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WASTEWATER MANAGEMENT STUDY FOR CLEVELAND - AKRON METROPOLITAN --ETC(U)
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WASTEWATER MANAGEMENT STUDY

1970

APPENDIX IV
INDUSTRIAL WASTEWATER

1985

AUGUST 1973

FOR

CLEVELAND – AKRON METROPOLITAN

AND

THREE RIVERS WATERSHED AREAS

(6) Wastewater Management Study for Cleveland and Akron (1)

ALTERNATIVES FOR ~~MANAGING WASTEWATER IN THE~~ THREE RIVERS WATERSHED AREA

Appendix IV.

INDUSTRIAL WASTEWATER, ~~STUDY~~

PHASE I - DATA ACQUISITION AND DEFINITION OF PROBLEM

Submitted to

BUFFALO DISTRICT U. S. ARMY CORPS OF ENGINEERS

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INTRODUCTION

This investigation was concerned with the development of comprehensive wastewater management alternatives for the Cleveland-Akron metropolitan area. The work was a continuation of a feasibility study prepared in 1971. The industrial waste study was one of three technical parts of the Survey Scope Study. The Phase I report deals primarily with the identification of industrial waste loads in the Study Area. Subsequent phases were concerned with the design of treatment facilities and the cost of industrial water pollution control.

OBJECTIVES

The principal objective of the Phase I investigation was to identify the industrial wastewater management problem as it exists today and is anticipated to exist in the future.

Specific objectives of the study may be enumerated as follows:

1. To inventory significant industrial wastewater effluents within the Study Area which discharge directly to receiving waters or to municipal collection systems; —> next page

cont

2. To project industrial waste discharges on ten year intervals to obtain estimates of wastewater flows for the years 1990-2020;

3. To evaluate the wastes produced by each industrial category with respect to their compatibility for treatment in municipal wastewater systems;

4. To delineate water requirements by specific industrial groups for different uses and identify sources of water which might be reused;

5. To determine wastewater management policies being considered or implemented by state and local agencies and the effect of these policies on the treatment of industrial wastes; and

6. To discuss the applicability of combined industrial wastewater treatment within special industrial wastewater treatment facilities and to discuss the feasibility of two such projects within the Study Area.

INDUSTRIAL WASTEWATER MANAGEMENT IN THE THREE RIVERS WATERSHED AREA

INSTITUTIONS INFLUENCING WATER QUALITY MANAGEMENT

Agencies Capable of Financing Treatment Facilities

Under laws of the State of Ohio, wastewater treatment facilities may be financed in three ways. Constitutional provisions for "home rule" give local communities the right to form utility districts to provide suitable treatment of wastes. Municipalities may form districts to provide wastewater collection and treatment either by themselves or in cooperation with other municipalities. In addition, communities may contract with other sewage districts to accept wastes.

County sanitary engineering departments may also provide facilities for wastewater collection and treatment for all or part of a county. In providing services, the county may establish sewer districts or contract for handling of wastes in a particular area through an existing municipality in much the same manner that local communities can arrange for wastewater treatment. While there is some doubt concerning the authority of a county to operate facilities for individual housing developments, many counties are operating and maintaining facilities owned by these developments.

Sewer authorities formed by municipalities or county sanitary engineering departments have the power to establish their own regulations regarding the acceptance of industrial wastes into the system. Each sewer district is responsible for conforming to water quality standards established by regulatory agencies; however, the attainment

of these standards is generally left up to the individual sewer districts. The degree of control sewer authorities maintain over the acceptance of industrial wastes is being increased in a number of districts due to the concern of the population about water pollution and with the implementation of more strict water quality standards. Agencies in both Cleveland and Akron are actively working to insure proper pretreatment of industrial wastes and exclusion of toxic and otherwise harmful discharges from municipal sewer systems where necessary. Steps taken by smaller municipalities generally vary according to the magnitude of local industrial waste problems. A great percentage of industrial wastes in the Study Area are presently discharged to municipal sewer systems; current attitudes of industries and sewer authorities indicate that this will continue to be the predominant method of disposal for industrial wastes in the forseeable future. Combined treatment is many times the least costly treatment method for industries. In fact, waste treatment costs can be held to a minimum for cities and industry due to economics of scale made possible by combined treatment. Specific industrial waste treatment policies of various cities in the Study Area are discussed in the section of Chapter III entitled "Present Industrial Wastewater Treatment Practice."

The third source of financing for wastewater treatment facilities is the Ohio Water Development Authority. Created in 1968 by the Ohio legislature, the purpose of the Authority is to provide for financing construction of wastewater treatment facilities through the issuance of revenue bonds payable from operational charges made for the use of

these facilities. Later in 1968, the legislature authorized the issuance of $120 million in bonds for use by the Authority.

Revenues available through the OWDA are available to industry as well as to any established sewer authority. Any industry having sufficient credit to secure the bond sale is capable of receiving OWDA financing with the stipulation that the planned facilities must be judged adequate to meet applicable water quality standards by the Ohio Department of Health. Facilities may be built on land owned by the industry. Operation of the facilities is generally handled by the industry. At the end of the financing period, the particular industry retains ownership of the plant.

This program provides a source of financing to industry at a lower interest rate since tax exemptions available through the state or federal government are not lost by the industry. The state, through this program, is expediting the construction of pollution abatement facilities without direct cost to the taxpayer. As of March 1, 1972, two industries had completed facilities under this program costing $2,500,000. Twelve additional projects costing a total of $39,700,000 had been proposed or were under construction. The financing capabilities of OWDA are further discussed in the chapter entitled "Combined Industry Treatment."

Federal funds for the construction of water pollution control facilities are available from several agencies. These are primarily matching funds available to political subdivisions which have met federal planning requirements. Efforts of local sewer authorities in

securing these funds are coordinated by local and regional planning commissions.

INDUSTRIAL WASTEWATER MANAGEMENT PLANNING

A major consideration for developing industrial waste treatment strategies in this study was given to plans which have been formulated in other planning efforts. Wherever possible, present and proposed industrial wastewater management policies were incorporated into the plans developed in this study. In order to relate the findings of past planning efforts and to serve as a basis for decisions made in performing this study, a brief review of past studies dealing specifically with industrial wastes will be presented.

Northeast Ohio Water Development Plan

This plan [3] is the major effort of the State of Ohio to provide comprehensive plans for use of the state's water resources. It provides for the development of raw water supplies for all legitimate uses, and requires the construction of pollution abatement facilities and enforcement to protect the quality of these waters.

In order to assess the effect of industrial wastes on the water resources in Northeastern Ohio, significant industries in the area were inventoried. Sources of data used were the files of the Department of Health and questionnaires mailed to industries. The adequacy of pollution control for 262 industries which discharge wastes to streams

were evaluated in general terms. Approximately half of these industries are located in the Three Rivers basins. The exact processes required to correct deficiencies in current treatment practices were explicitly delineated. Of the 262 industries surveyed, 98 were classified by the Ohio Water Pollution Control Board as being adequate and 88 as inadequate to meet State water quality standards in force at that time. The additional 76 industries were not under permit.

Total industrial waste load discharged from treatment facilities in 1969 was estimated to consist of 1,560 mgd flow, 297,200 lb BOD/day, 888,200 lb COD/day, 757,000 lb suspended solids/day. Apparently the loads from municipal plants included wastes from industries treated in these systems.

Recommendations contained in the Northeast Plan were made for individual river basins and as general wastewater management plans for specific area-wide problems. Industrial treatment requirements for the Rocky River basin were principally related to two industries having wastes from metal finishing processes. Capital costs required for compliance with water quality standards were estimated to be $440,000 for the first decade of implementation of the Northeast Plan. The Plan also called for the removal of all significant waste treatment plant effluents from the lower Rocky River.

In the Cuyahoga River basin, the principal industrial sources of pollution were said to be from the rubber industry in Akron and

the steel industry in Cleveland. First decade capital costs were estimated to be $90,670,000 involving facilities in 33 industries. The majority of these costs were associated with the steel mills. Problem areas in the Akron vicinity were identified as the need for pretreatment of noncompatible wastes in selected industries and the control of surfactants to lessen problems of foam collection behind dams. Both problems are curently being dealt with by the City of Akron.

Specific recommendations were made for improvement of water quality on the Lower Cuyahoga. This plan included:

1. Reduction of upstream pollution loads by implementing the recommended plan, especially for the Akron and Cleveland Southerly treatment plants.
2. Collection of oils, greases, paint, solvents, etc. for reclamation or disposal at a central plant. The abandoned Kingsburg Run refinery in Cleveland was proposed for use in this manner as proposed in an earlier report of Battelle Institute to the Ohio Water Development Authority [4]
3. Collection of heavy metals, pickle liquors, plating wastes, and similar wastes for treatment in separate industrial waste facilities.
4. Pretreatment of strong oxygen demanding wastes where discharge of these materials to municipal systems would adversely affect performance of these facilities.

5. Installation of cooling towers by large consumers of cooling water to reduce heat discharges.

6. Evaluation of costs required to lower dissolved solids concentration using several methods and an examination of benefits associated with the reduction of dissolved solids.

Additional recommendations were listed; however, these did not directly apply to industrial wastes. Recommendations calling for the concentration of waste discharges at five regional treatment plants were not specific as to the effect of this plan on present industrial discharges directly to streams.

Industrial waste facilities recommended for the Chagrin River basin amounted to capital expenditures of $290,000. These costs principally involved two industries, although seven were listed as having inadequate facilities. In addition, it was recommended that all major discharges downstream of Chagrin Falls and on the East Branch of this river be eliminated.

Several general recommendations were made to rectify regional water management problems. Two of these might directly affect waste abatement and water use practices by industry. One was the recommendation that recycled wastewater be recognized as a water source for the generation of an adequate water supply for future demands. The second proposal was that deep well injection of industrial wastes not be recommended for general practice. This was based primarily on the low permeability of available strata in Northeastern Ohio.

Costs to implement all recommendations of the plan for industrial waste treatment totaled $208,640,000 in capital expenditures and an estimated $17,300,000 annually for operation of these facilities based on 1970 price levels. The impact of such a program on industry might vary greatly with the size of the industry and the amount of treatment required. Estimates for the steel industry showed that pollution control measures would increase production costs approximately $2.10/tn or 1.5 percent. Capital costs would constitute approximately 2.9 percent of the total plant investment.

Great Lakes Basin Commission Framework Study

The objective of this study [5] is to provide a comprehensive joint plan for federal, state, interstate, and local development of water and related resources in the Great Lakes basin. Although the plan will not be completed until the spring of 1973, drafts of most portions of the report have been published for review. A review of the study contained in the GLBC 1971 Annual Report [6] indicated that policy recommendations being formulated will be very broad in nature. It appears that the principal impact of this study will be recommendations encouraging inland dispersal of industry by development of regional water supply facilities and requiring advanced treatment of wastes in all of the Three Rivers basins. Costs required to treat industrial wastes to these levels were not estimated because of inadequate data concerning waste flows.

Cleveland Industrial Waste Survey

The City of Cleveland commissioned Dalton-Dalton-Little of Cleveland and Resource Engineering Associates to assemble information needed for the City to develop an industrial waste treatment charge system and to assess the treatment of wastes in the Cleveland area necessary to protect the principal receiving streams of the city [7]. A major portion of the study included an inventory of industrial wastes originating in the Cleveland sewer districts. This inventory included a questionnaire survey and sampling of all major industries. Becuase this survey contained data for specific industires located in the Study Area, it was used as a primary source of dat in this study. Included in the survey were the manufacturing SIC categories, laundries, car washes, incinerators, and power plants.

From a study of the Cuyahoga River and measures required to rehabilitate the River, it was concluded that removal of phosphorus and nitrogen and additional BOD removal in Cleveland was needed, but that additional treatment above Cleveland would be necessary to effect a significant improvement in water quality of the navigation channel. In another part of the study, a review of treatment facility financing and waste treatment charges was made. With respect to industrial waste policies it was recommended that discharge of wastes to city sewers be required where sewers are accessible and that a rate structure for industrial wastes be implemented based on actual treatment costs.

Lake Erie Report

In very general terms, the conclusions of this report [8] recommended the equivalent of secondary treatment for all industrial wastes and specific facilities for additional treatment in the steel, chemical, rubber, paper, and food industries. Industries lacking adequate treatment facilities were named to encourage rapid compliance with these recommendations. Readily available industrial waste discharge data was presented. Industrial waste treatment needs were estimated to cost $90,000,000 for the Cleveland-Akron area, although no specific details were given.

Water Pollution Study of Cuyahoga River Basin

This is one of several studies made of the Cuyahoga River by the Ohio Department of Health for assessing water quality at a particular time and evaluating the adequacy of wastewater treatment facilities along the river [9]. Specific recommendations for industrial wastes contained in the report included new treatment facilities or control measures for 21 industries and additions to facilities at another 11 plants. Eight industries were judged to have adequate facilities. Data for industries discharging wastes directly to receiving waters such as treatment provided, waste load, and specific remarks concerning industry production practices was also included.

Report and Recommendations on Water Quality for the Rocky, Cuyahoga, Chagrin and Grand Rivers

This report prepared by the Ohio Department of Health [10] contained a summary of industrial waste treatment facilities existing in 1968 and improvements which were needed for compliance with recommended water quality standards. Principal industries discharging to the Rocky River were identified as a metal finishing processor, a pickle cannery, and a research center of the National Aeronautics and Space Administration.

In the Cuyahoga basin, problems in the Akron area were identified as rubber manufacturers, a salt company, sand and gravel washers, and metal finishing firms. Industrial waste problems in the Akron treatment plant were said to consist of finely divided solids from the rubber industry, nitrites contained in rubber particles which are converted to ammonia through biological action, brine solutions contributed by a salt company, acids, alkalis, and aromatic organics. Since 1968, significant progress has been made in correcting these problems.

In the Cleveland area, 22 industries under state permits were identified as contributing waste discharges to the main branch of the Cuyahoga. These included 13 steel processing plants, six chemical firms, two paper mills, and one steam generating station. Problems were reported to be acids and iron from pickling of steel, suspended solids, and oil. Treatment provided by the chemical firms and paper mills was reported to be generally adequate.

In the Chagrin basin, treatment facilities provided by three industries were judged adequate, while those of three others required additions or improvements. Modifications called forincluded additional aeration capacity of an aerated lagoon system, improved maintenance of clarification facilties, and completion of plans for connecting to city sewers.

Cuyahoga River Water Quality Study

This report [11] was prepared by the Cuyahoga River Basin Water Quality Committee to evaluate water quality of the Cuyahoga River and to estimate the cost required to upgrade water quality for various uses. It was concluded that with the completion of facilities for two municipalities and three steel companies under construction in 1966, the water quality would still not meet criteria for recreation, aquatic, and public water supply at critical flow.

Further, it was estimated that the additional expenditure of approximately $10,000,000 in capital improvements and a $1,000,000 annual operating expense would be required to correct remaining deficiencies in dissolved oxygen, temperature, odor, and dissolved solids. Included in this estimate were facilities for dissolved solids reduction at two points, cooling towers for large water users on the Lower Cuyahoga, and artificial reaeration in the navigation channel. Even with this expenditure, it was estimated that concentrations of coliforms, floating debris, sludge, and color would still exceed the criteria for aesthetic, recreation, and public water supply uses.

WATER QUALITY STANDARDS

Water quality standards which must be attained by discharges to waterways have become increasingly stringent in the last few years. Moreover, much conflict has developed over the authority of various agencies to establish and enforce water standards. Standards proposed by these agencies have not been firmly established and implemented. Compliance with new standards will be difficult until the exact meaning of these standards are established.

Two levels of water quality standards were considered in this investigation. Water quality standards established by the Ohio Water Pollution Control Board (now the Ohio Environmental Protection Agency) were based on the attainment of quality levels required for various water uses. During 1972 these criteria were rewritten as effluent standards to achieve the same water quality. These standards were referred to as "Level I goals" in this study. Standards developed by the Corps of Engineers to reflect the national "no discharge" of pollutants goal was referred to as "Level II goals" in this investigation. While these criteria approximate treatment levels which will be required for industrial discharges, the federal Environmental Protection Agency is in the process of developing effluent guidelines for individual industrial categories. These guidelines will set allowable discharges from industries unless

local water standards require more treatment. Guidelines presently being developed will apply to "best practicable technology" required for implementation by 1977. For many industries the 1977 EPA guidelines will perhaps be less stringent than the Level II goals identified in this investigation. Additional guidelines will be developed for "best available treatment" required by 1983. At the present time, there is no indication regarding the technical content of these guidelines. Because the industrial guidelines have not been determined, it was necessary to apply Level I and II treatment criteria to industrial wastes.

State of Ohio Standards

Water Quality Standards established by the Ohio Environmental Protection Agency are divided into three sections: 1) inland waters including all surface and ground waters within the State of Ohio; 2) the Ohio River; and 3) Lake Erie and interstate waters tributary to the Lake. A full statement of stream standards applicable to the waterway waters of Ohio are included in Attachment A. Standards are given for the various water uses established by the Ohio Water Pollution Control Board. These uses include public water supply, industrial water supply, support of aquatic life, recreation, and agricultural use and stock watering. Water quality uses which have been established by the Ohio EPA for the Rocky, Cuyahoga, and Chagrin Rivers are summarized in Tables I, II, and III.

TABLE I

ROCKY RIVER WATER QUALITY CRITERIA

Reach	Aquatic Life A	Industrial Water Supply	Public Water Supply	Cold Water Fish	Partial Body Contact	Full Body Contact
Rocky River and all tributaries	X	X			X	
East Branch and Baldwin Creek near reservoir	X	X	X			
East Branch at Albion Park	X	X			X	X

TABLE II

CUYAHOGA RIVER WATER QUALITY CRITERIA

	Aquatic Life A	Industrial Water Supply	Public Water Supply	Partial Body Contact	Full Body Contact
Cuyahoga River from S.R. 17 to Coast Guard Station	X	X			
Cuyahoga River from Lake Rockwell Down to S.R. 17	X			X	
Little Cuyahoga River upstream of S.R. 91 and downstream of Hazel Street, Akron	X	X		X	
Little Cuyahoga River between S.R. 91 and Hazel Street, Summit Lake and the Ohio Canal	X	X			
All other tributaries between Lake Rockwell and Harvard Avenue, Cleveland	X	X		X	
Upper Cuyahoga River Basin above Lake Rockwell Dam	X	X	X		X
Lakes, Hodgson, Muzzy and Sandy	X	X	X		X
Lakes, currently in use for swimming and water contact sports	X	X			X

TABLE III

CHAGRIN RIVER WATER QUALITY CRITERIA

	Aquatic Life A	Industrial Water Supply	Public Water Supply	Cold Water Fish	Partial Body Contact	Full Body Contact
Chagrin River and all tributaries	X	X			X	
East Branch and Main Stem near Daniels Park	X	X	X		X	
Main Stem upstream of Chagrin Falls	X	X		X	X	
Aurora Branch	X	X		X	X	
East Branch	X	X		X	X	

Minimum conditions applying to all waters specified in the standards are essentially the "four freedoms" established by the Ohio River Valley Water Sanitation Commission. Additional criteria applicable to most of the water uses are specified in the standards included in Attachment A. Not included in these standards are specific criteria for partial body contact and cold water fisheries. Standards for partial body contact (wading and boating) specify that coliform concentrations should not exceed 5,000/100 ml as a monthly average value nor exceed this number in more than 20 percent of the samples examined during any one month. It is additionally specified that no more than 5 percent of the samples should exceed a coliform count of 20,000/100 ml. Waters to be used for cold water fisheries should contain a minimum dissolved oxygen concentration of 6.0 mg/l, a maximum water temperature of 70°F, and pH ranging between 6.5 and 8.5.

Water usages classifications for streams in the state have been, in many cases, upgraded by the Water Pollution Control Board in the past few years. In April, 1972 the board discontinued the use of Aquatic Life B standards and upgraded all waters previously classified in this category to Aquatic Life A. In the Three Rivers basins, this decision affected three reaches of the Cuyahoga River previously classified as Aquatic Life B, including the navigation channel which flows through the heavily industrialized part of Cleveland, the portion from the navigation channel to Lake Rockwell, and part of the Little Cuyahoga River. Considering the poor reaeration characteristics of the Lower Cuyahoga River, it will be extremely

difficult to maintain the required average dissolved oxygen concentration of 5.0 mg/l required by water quality standards. If fully implemented, these standards will have a significant effect on industries discharging wastes to the lower Cuyahoga River.

Because of the difficulty in implementing stream standards in areas where there are many waste discharges to a stream, present Ohio water quality standards are temporary and are being replaced by effluent standards. It is expected that these standards will be written to maintain approximately the same water quality as that specified in present stream standards, but that they will be more specific with respect to the concentrations of certain substances such as heavy metals and toxicants which may be present in waste discharges. Effluent standards applying to municipal and industrial wastewater discharges to surface waters are currently being developed by the Ohio Department of Health. Pollutant concentrations which are likely to be specified in these standards are summarized in Table IV [12].

At the present time there is some doubt as to whether these concentrations are aboslute values which must be met in wastewater discharges or whether allowance will be made for pollutant concentrations present in intake waters. It will be more difficult to base enforcement on net concentrations, especially when a particular industry obtains water from more than one source, each having a different quality. However, it may also be argued that water users should not be held responsible for pollutants introduced into the water by other users or from natural sources.

TABLE IV

WATER QUALITY GOALS - EFFLUENT

STANDARD BASIS

Constituent	Effluent Requirement: Proposed Ohio Standards		Effluent Requirement: Corps of Engineers Goals
Settleable Solids	Substantially complete removal: Monthly Ave. 0.3 mg/l Monthly max. 1.0 mg/l		Trace
Oils (and grease)	Lowest practical level attainable by today's technology. Monthly ave. 10 mg/l Monthly max. 20 mg/l		Trace
Debris, Scum, Floatables	Substantially complete removal		None
Suspended Solids (Inert)	Reduction to such a degree as to not cause noticeable turbidity in the receiving stream, but shall not exceed:		2 mg/l
	Free Flowing Warm Water Fisheries	Cold water Fisheries Pooling Streams Scenic Rivers, Reservoirs, and Inland lakes	
	Monthly ave. 30 mg/l Monthly daily 45 mg/l	Monthly ave. 20 mg/l Monthly daily 30 mg/l	
Color	Effluent imparts no objectionable color nor increases the background level by 5 standard units		75 Color Units
Taste and Odor	Reduction to such a degree as to not cause an objectionalbe odor, a threshold odor number 725 to potable water supplies, nor cause fish flesh tainting.		Not offensive
Toxic Constituents	Reduction of any and all materials to such a degree that the concentration thereof, singly or in combinations, in any discharge is not harmful to human health or aquatic life to such a degree that the concentration thereof in the discharge does not kill 25% of a mixed fish population common to the receiving stream in a 1:1 dilution of the sample with waters of the receiving stream provided that the calculated concentration in the receiving stream does not exceed 1/20 of the 96 hour median tolerance limit.		Critical levels for all constituents not specifically mentioned shall be based upon natural background levels of the receiving watercourse or aquifer with exception of constituents that are highly toxic or injurious to the environment at trace levels. If current State water quality standards are higher, these standards shall apply; or levels of nontoxic constituents may be relaxed upward (above background levels) should they be proven to be injurious to the environment of the region.

TABLE IV (cont'd)

WATER QUALITY GOALS - EFFLUENT

STANDARD BASIS

Constituent	Effluent Requirement Proposed Ohio Standards	Effluent Requirement Corps of Engineers Goals
Arsenic	0.05 mg/l	Absent
Barium	1.0 mg/l	Absent
Cadmium	0.01 mg/l	Absent
Chromium		
hexavalent	0.05 mg/l	Absent
total	0.30 mg/l	Absent
Copper	1.0 mg/l	Absent
Iron		
total	5.0 mg/l	No comment
soluble	0.3 mg/l	No comment
Lead	0.05 mg/l	Absent
Mercury	0.005 mg/l	Absent
Nickel	0.01 mg/l	Absent
Silver	0.05 mg/l	Absent
Zinc	5.0 mg/l	Absent

Phosphorus

Proposed Ohio Standards:

Wastewater Volume (mgd)	Effluent Concentration (mg/l - P) 1975	Effluent Concentration (mg/l - P) 1980
Discharges to:		
(a) Free Flowing Tributaries to Lake Erie		
10+	1.0	0.5
1-9.9	1.0	1.0
1.0	8.0	1.0
(b) Free Flowing Tributaries of Ohio River		
50+	1.0	0.5
10-49.9	2.0	1.0
1-9.9	8.0	2.0
(c) Lakes, Reservoirs, Significant Impoundments and Pools		
1.0+	2.0	0.5
1.0	8.0	1.0

Corps of Engineers Goals:

Entering a Lake: 0.05 mg/l as PO_4

Entering a Flowing Stream: 0.10 mg/l as PO_4

Temperature

Proposed Ohio Standards:

(A) Warm Water Fisheries
Reduction of heat content so that in no case the discharge increases the river temperature by more than 5°F, if below the following formula applies:

Allowable Heat Discharge Rate (BTU/sec)
= 62.4 (River flow, CFS)($T_A - T_R$)(90%)
T_A = Allowable Maximum River Temp.

Month	Jan	Feb	Mar	Apr	May	Jun
T_A	50	50	60	70	80	90
Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
T_A	90	90	90	78	70	57

T_R = River Temp. (daily ave.) above discharge

Constituent	Proposed Ohio Standards	Corps of Engineers Goals
Turbidity	No Comment	5 Jackson Units
Dissolved Solids	Control to such a point that the discharged dissolved solids load does not increase the dissolved solids concentration in the receiving waters by more than 5% on a calculated basis provided that (a) the dissolved solids criterion in the receiving waters is not exceeded, or (b) the dissolved solids concentration in the discharge does not exceed five times the dissolved solids criteria for the receiving water	500 mg/l w/specific limits established for specific inorganics, CO_2 25 mg/l SO_4 10 mg/l Ca 30 mg/l Cl 250 mg/l Na 10 mg/l Mg 125 mg/l Fl 1.7 @ 10°C to 0.8 mg/l @ 30°C. Al 1 mg/l HCO_3 ±50 mg/l variation from ambient conditions Mn 0.5 mg/l

TABLE IV (cont'd)

WATER QUALITY GOALS - EFFLUENT

STANDARD BASIS

Constituent	Effluent Requirement: Proposed Ohio Standards	Effluent Requirement: Corps of Engineers Goals
Dissolved Oxygen	Streams classified as warm water fisheries 4.0 mg/l Streams classified as cold water fisheries 6.0	no comment except $BOD_5 <$ effluent DO
Deoxygenating Wastes (BOD_5 and SS)	Reduction so that DO levels of receiving stream is not depressed below established criteria and in accordance with the following criteria:	BOD_5 2 mg/l SS 2 mg/l

Class I - Cold Water Fisheries

Effluent Concentrations:

BOD_5-mg/l Monthly Average	BOD_5-mg/l Maximum Daily	SS-mg/l Monthly Average	SS-mg/l Maximum Daily	Calculated Increase In Stream @ Critical Flow (mg/l)
15	23	18	25	0.3
10	15	12	18	0.4
7	10	10	15	0.5
5	8	8	12	0.6
Class II - Scenic Waters, Streams, Reservoirs, and Lakes				
15	23	15	25	0.3
10	15	12	18	0.4
7	10	10	15	0.5
5	8	8	12	0.6
Class III - Free Flowing Warm Water Fisheries (for at least 15 miles below discharge)				
30	45	30	45	0.5
25	40	25	40	1.0
20	30	20	30	2.0
15	25	15	25	3.0
10	15	12	18	4.0
7	10	10	15	4.5
5	8	8	12	5.0
Class IV - Pooling Streams, Impoundments, Back Waters and Lakes Classified for Warm Water Fisheries				
20	30	20	30	0.5
15	25	15	20	1.0
10	15	12	18	2.0
7	10	10	15	3.0
5	8	8	12	5.0

Exceptions for Class III and IV Waters

(A) In congested heavily populated and industrial corridors where discharges of a number of identities contribute to single or multiple water quality violations - additional reductions will be required as follows:

1. Additive effects of multiple discharges shall not exceed requirements of one discharge of the combined wastes at one point, or
2. Effluent requirements will be determined by river studies w/ appropriate allotment of waste loads provided no discharge exceed requirements for Class III and IV Streams.

(B) If slope $>$10 ft/mile or low flow depth

TABLE IV (cont'd)

WATER QUALITY GOALS - EFFLUENT

STANDARD BASIS

Constituent	Effluent Requirement Proposed Ohio Standards	Corps of Engineers Goals
Deoxygenating Wastes (cont'd)	<1.0 ft and free of pooling - allowable incremental increase in BOD_5 if 50% (C) For isolated communities of 1500 or less and an untreated waste load of <2000 PE that discharges to a dry weather ditch and for which lagoons are the only practical method of treatment, allowable effluent quality will be: BOD_5 = 30 mg/l, SS = 45 mg/l	
Ammonia Nitrogen	Stream Class / April -Oct (mg/l) / Nov- Mar (mg/l) / Calculated Increase In Stream @ Critical Flow (mg/l) I & II — 2.0 — 4.0 — 0.10 III & IV — 10.0 — 15.0 — 0.5 5.0 — 10.0 — 0.10 2.5 — 5.0 — 0.15	0.1 mg/l as N
Organic Nitrogen	No comment	Total Nitrogen - 10 mg/l as N
Nitrates and Nitrite	No comment	4.0 mg/l as N
Aluminum	No Comment	1.0 mg/l
Antimony	No comment	absent
Berryllium	No comment	absent
Boron	No comment	absent
Cobalt	No comment	absent
Molybdenum	No comment	absent
Selenium	No comment	absent
Thallium	No comment	absent
Tin	No comment	absent
Titanium	No comment	absent
Cyanide		
total	0.2 mg/l	absent
free	0.025 mg/l	absent
Phenols	0.3 mg/l	absent
Aldrin	0.017 mg/l	
Chlordane	0.003 mg/l	
DDT	0.042 mg/l	
Dieldrin	0.017 mg/l	
Endrin	0.001 mg/l	
Heptachlor	0.018 mg/l	
Heptachlor Epoxide	0.018	Pesticides and chlorinated hydrocarbons - absent
Lindane	0.056 mg/l	
Metoxychlor	0.035 mg/l	
Organic PO_4 Carbonates	0.1 mg/l	
Toxaphene	0.005 mg/l	
Radioactive M Materials	Reduction to such a degree that (1) concentrations of <u>unidentified</u> radionuclides in the discharge do not exceed (a) 30 pcl or (b) limiting values specified by the AEC for water in which certain radionuclides are known to be absent; or (2) concentrations of identified radionuclides do not exceed limits specified by AEC.	Alpha Radiation 1 pcl Beta Radiation 100 pcl Gamma Radiation - Trace
Fecal Coliform Bacteria	May through October: 200/100 ml - monthly geometric mean 400/100 ml - 90% less than, monthly November through April: 1000/100 ml - monthly geometric mean (Based on >10 sampes/month)	200/100 ml
Virus	No comment	Inactivated, but present at trace levels
Fecal Streptococci	No comment	Inactivated, but present at trace levels
pH and Alkalinity	5 - 9, pH values up to 10 provided the OH^- concentration does not exceed 10 mg/l if the discharge does not violate water quality standards.	Alkalinity 100-130 mg/l when pH is 6-7

Federal "No Discharge" Standards

The Federal Water Pollution Control Act Ammendments of 1972 specify a national goal of no discharge of pollutants into receiving waters to be accomplished by 1985. In planning for wastewater management needs of the year 2020, one objective of this study included the evaluation of these standards with respect to industrial wastewater control. Because the exact meaning of no discharge standards have not been established, it was necessary to define pollutant levels which would be allowed in wastewater discharges under such standards. For this purpose, the U.S.Army Corps of Engineers developed a list of critical pollutants and arbitrary concentration levels which will be anticipated for no discharge standards [13]. Concentration levels have been defined as 1) absence (concentrations less than those measurable by the most sensitive analytical procedure available), 2)virtual absence (approaching 100 percent removal), and 3) background levels (concentrations not greater than specified levels). Substances defined which should be absent include heavy metals, phenol, cyanide, and pesticides. Substances which should be virtually absent from wastewater discharges include BOD, oil and grease, floatables, total organic carbon (TOC), etc. Other substances which are acceptable at background levels include dissolved solids, nutrients, turbidity, alkalinity, and hardness. A complete listing of these substances is included as Table IV.

LOCAL INDUSTRIAL WASTEWATER MANAGEMENT POLICIES

Because the great majority of industries contained in the Study Area discharge wastewaters directly to city sewers, municipal waste treatment policies will significantly affect the management of industrial wastewaters. In order to determine the attitudes of local authorities toward industrial wastes, discussions were conducted with personnel of the Cleveland and Akron sewer authorities with regard to existing management policies and the interpretation of these policies with respect to industrial discharges. A summary of these policies, anticipated changes, revisions, and modifications will be discussed in this section as well as the probable affects of such changes on industrial wastewater treatment.

The prevalent attitude of local authorities in the past has been to accept industrial wastes for treatment in the municipal wastewater facilities. This is usually a necessity for industries in urban areas since space for adequate treatment facilities is not available. In addition many industries are not located adjacent to its waterways. In addition, cities frequently have accepted industrial wastes into city systems as an incentive of attracting new industries to the area.

Historically, control of industrial discharge to municipal sewer systems has, in many cases, been less than adequate to allow for proper operation of sewage treatment plants. The Ohio Department of Health in May, 1968 [10] identified several operational

problems of the Cleveland and Akron wastewater treatment facilities resulting from inadequate control of the industrial waste discharges to city sewers. Since that time, sewer authority officials in several cities have worked to correct these problems. At the present time these cities encourage the discharge of industrial waste to city sewers following any necessary pretreatment. Specific policies of these two municipalities are outlined below.

City of Cleveland Industrial Wastewater Management Policies

Industrial Waste Treatment Charge System. The City of Cleveland Department of Public Utilities has recently developed extensive guidelines for the discharge of industrial wastes to the city sewer system and an industrial wastewater treatment charge system. To have maximum control on the water quality of the lower Cuyahoga River, the city is encouraging all industries to discharge cooling and process waters to city sewers rather than directly to the river. Although this policy will have the effect of introducing large quantities of uncontaminated water to treatment facilities, city officials feel that this type of program is necessary for the restoration of desirable water quality in the river. City officials expected to be treating waste flows from 75 percent of the industries located in the city's collection districts by the end of 1972. The ultimate goal of the City of Cleveland is to treat all industrial wastes originating within the city collection districts [14, 15, 16].

The industrial waste treatment charge system being developed by the City will assess costs to industry based on the actual treatment costs. Charges to industry will be based on three factors: waste flow, suspended solids, and BOD. Charges for nitrogen and phosphorus will be included as nutrient removal processes and are added to treatment facilities. The target date for implementation of this program was late 1972.

The rate schedule developed set a minimum treatment charge equivalent to the fee for wastes having the same BOD and suspended solids concentration as domestic wastes. By establishing a minimum charge, the costs assessed to the user per unit of contaminant increases as the waste becomes more dilute compared to "average" domestic wastewater. It is anticipated that this rate structure will discourage industries from discharging excessive quantities of waste to the municipal sewer system and will encourage reuse of water by industry.

To establish rate schedules, each industry was required to submit information requested on a one-page questionnaire. Information required is essentially the volume of waste discharged to sewers and suspended solids and BOD concentrations. For industries which do not have the capability to make such measurements or which do not report data, the City of Cleveland will apply average wastewater flows and contaminant concentrations characteristic of that industrial category. Each industry will have the opportunity to contest these values if it can prove that lower concentrations apply to their particular wastestream. Conversely, the City of Cleveland

will make spot checks to verify data reported by industry. In most cases, the charge for the volume of wastewater discharged to sewers will be based on water usage recorded from water meter readings. Industries obtaining water from other sources will be required to accurately meter this volume and report this data to city authorities.

In order to adequately protect the city sewers and waste treatment facilities and provide for the safety of sewer district employees, certain substances are specifically excluded from discharge to the city sewer system. These substances include ones such as solvents, strong acids and alkalies, and inflammable materials which would destroy sewers and waste treatment facilities, harm employees, or upset operation of waste treatment processes. Only limited concentrations of certain other substances which would upset waste treatment processes or which would escape untreated to the receiving water are permitted. Allowable discharges of these substances which include oil and grease, heavy metals, cyanide, phenols, dissolved solids, etc., will depend on loads being discharged to treatment plants at a particular time.

Provisions have been made for the discharge of certain materials limited by the regulations while adequate pretreatment facilities are being constructed. During a period allowed for construction of pre-treatment facilities, the discharge of certain substances (oil, metals, etc.) is being permitted in concentrations exceeding normal limits

on a temporary basis. Charges assessed for these materials are high in order to encourage rapid installation of the pretreatment facilities.

Regional Sewer Authority. For several years, the City of Cleveland has contracted for the treatment of wastes from surrounding communities in the three sewage treatment plants owned by the city. Recently the formation of an independent sewer authority to assume wastewater treatment responsibilities for Cleveland, 37 suburbs, and two townships was ordered by a Cleveland Court [17, 18]. Although final plans have not yet been completed, the authority will most likely be governed by a board of trustees comprised of three members from the City of Cleveland, two from surrounding communities, and two appointed by the governor. The effect of this plan on industrial waste treatment policies of the area remain unclear, but no significant changes are expected.

City of Akron

Personnel in the City of Akron have solved many problems related to proper operation of the city wastewater treatment plant in the last few years by requiring pretreatment of certain wastes by industry and encouraging water reuse. City officials are pleased with progress that has been made so far in the control of wastes from rubber manufacturers and one salt producer in the Akron area. Water reuse practices which have been instituted by the salt producer have reduced chloride discharges from the Akron treatment plant to

approximately background levels. Previously, total dissolved solids concentrations in the Cuyahoga River increased approximately 300 mg/l downstream from the Akron wastewater treatment plant according to 1965 data [10].

Policies of the City of Akron are approximately the same as those for the City of Cleveland with respect to the acceptance of industrial waste into the municipal sewer system. However, the significant difference exists in the policies of these two cities concerning disposal of uncontaminated cooling water flow. It is the opinion of the City of Akron officials that the discharge of uncontaminated cooling waters to city sewers serves only to dilute raw wastewaters and add to the problems associated with achieving adequate performance in the city wastewater treatment plant. Therefore, present policy in Akron is to discourage the discharge of uncontaminated cooling water to city sewers, but rather to reuse cooling water, discharging only blowdown to city sewers and to discharge uncontaminated water to city storm sewers or to surface waters.

Specific provisions for the assessment of charges for industrial waste treatment by the city are contained in the Akron City Code (Sections 533.01-533.15). Provisions are made for charging industry for concentrations of suspended solids and BOD exceeding values ascribed to normal domestic wastewaters. A formula is used to compute industrial charges which expresses the waste load discharged by an industry in terms of an equivalent volume of waste having the strength of an average domestic sewage. Thus charges assessed to industry by

the city increase in direct proportion to the volume of water used in the concentration of suspended solids BOD present in the waste. In practice, surcharges are usually not assessed to industries that pretreat their wastes in accordance with standards set by the city. A sampling and monitoring program has been instituted to identify industries which should pretreat wastes to verify compliance with city pretreatment requirements [19].

City ordinances relating to the discharge of industrial wastes to the city sewer system specify that the discharge to the following substances are unacceptable: fats or similar substances which may solidify in sewers, concentrations of oils exceeding 100 mg/l, any flammable or explosive materials, improperly comminuted garbage, excessive amounts of phenols which cannot be treated in city waste treatment facilities to meet established water quality standards, acid or alkali capable of causing damage or hazard in sewers, cyanides in excess of 2 mg/l, toxic materials capable of causing interference with wastewater treatment processes, temperatures greater than 150°F, and radioactive wastes which would cause the city to be in violation of state and federal regulations. In addition acceptable concentrations of heavy metals were established as follows: 5 mg/l iron, 2 mg/l hexavalent chromium, 1 mg/l copper, 2 mg/l zinc, 2 mg/l cadmium, and 1 mg/l lead.

In order to comply with federal regulations requiring assessments for industrial waste treatment corresponding to actual treatment costs incurred by the city [20], the City of Akron is planning major

changes in its industrial waste treatment charge system. The City has recently completed a master plan for wastewater treatment services which addressed problems related to providing adequate sewerage and wastewater treatment services in the future. Recommendations for industrial wastewater treatment concerned pretreatment of industrial wastes and industrial plans for the future which would affect the quantities of industrial wastes discharged to the city sewer system. In general it is expected that the city will continue the implementation of present industrial waste treatment policies.

The present industrial waste flow discharged to city sewers was estimated by city officials to be approximately 20 mgd. Of this total approximgtely 6.7 mgd is discharged by 11 major industries which either now have adequate pretreatment of wastes or are planning construction of pretreatment facilities for the near future. It is the opinion of city officials that these represent all of the principal sources of waste influent to the Akron system which require pretreatment.

EXISTING INDUSTRIAL WASTEWATER LOADS

INDUSTRIAL WASTEWATER TREATMENT PRACTICES

Approximately 5,000 industrial firms are located in the Three Rivers Watershed area. Most heavy industry in the Study Area is centered in Cuyahoga and Summit counties. Industiral areas outside these two urban centers are largely contained in several medium-sized towns in the area. A summary of employment for each two-digit category in the Study Area is shown in Table V. Major industires in the Study Area as indicated by employement are listed in Table VI. Industries listed in this table include all firms classified in SIC categories 20 through 32 having employment greater than 300; industries in SIC categories 33 through 39 having employment greater than 500 are listed. The location of these industries is shown in Figure 1.

Treatment in Municipal Systems

Local sewer authorities in the Study Area generally encourage the discharge of acceptable industrial wastes to municipal sewers. These policies were reviewed in detail in Chapter II. Greater than 95 percent of the industries in the Study Area discharge waste flows to municipal treatment systems. Industries which discharge wastes directly to receiving streams are frequently large water users or are located in unsewered areas. Because of favorable local attitudes

TABLE V

TOTAL MANUFACTURING EMPLOYMENT IN THE THREE RIVERS WATERSHED AREA[a]

SIC	Cuyahoga	Summit	Lake	Portage	Medina	Geauga	Lorain	Stark	Total
19	4,685	326	-	428	-	-	-	-	5,439
20	11,371	3,037	43	247	254	206	-	37	15,195
21	-	-	-	-	-	-	-	-	-
22	2,095	30	550	59	-	-	-	-	2,734
23	7,970	272	2	31	-	14	-	-	8,289
24	797	359	28	52	67	119	-	220	1,642
25	3,399	247	170	209	132	-	-	-	4,107
26	4,618	659	77	39	58	6	-	-	5,457
27	17,549	1,785	206	172	142	180	3	3	20,040
28	7,950	1,829	1,131	36	233	250	-	-	11,429
29	1,573	48	30	-	54	4	-	-	1,709
30	4,546	41,253	1,392	2,401	27	2,285	-	-	51,904
31	80	15	-	-	-	-	-	-	95
32	4,363	2,485	93	416	154	34	-	6	7,551
33	35,040	1,482	367	481	351	10	2	-	37,733
34	43,211	15,626	2,216	528	308	202	89	-	62,180
35	43,612	9,423	3,694	1,609	107	272	7	18	58,732
36	25,845	589	660	827	191	784	-	-	28,896
37	42,484	7,811	542	668	110	-	12	-	51,627
38	2,431	519	2,236	1	65	-	-	-	5,252
39	3,441	536	407	21	162	7	-	-	4,574
Total	267,060	88,331	13,784	8,225	2,415	4,373	113	284	384,585

[a] Values from Ohio Directory of Manufacturers [21]; employment for each county includes only firms located in the Study Area. Employment figures used for estimating projected industrial waste loads were obtained from another source [52]. These values are listed in Attachment G.

TABLE VI

SIGNIFICANT INDUSTRIES LOCATED IN THE THREE RIVERS WATERSHED AREA[a]

SIC No.	Industry	Location	Employment	I.D. No.[b]
Cuyahoga County				
2026	Kraftco Corp., Sealtest Division	Cleveland	0425	1
2037	Litton Industries, Inc.	Solon	0350	2
2051	Hough Bakeries, Inc., Hough Food Division	Cleveland	0450	3
2051	Laub Baking Company	Cleveland	0600	4
2051	Ward Foods, Inc., Ward Baking Co., Division	Cleveland	0375	5
2082	Schmidt Brewing Co., Inc.	Cleveland	0200	6
2086	Pepsico, Inc., Pepsi Cola Bottling Co.	Cleveland	0300	7
2653	Flintkote Co., Hankings Container Co. Division	Cleveland	0325	8
2653	St. Regis Paper Co., Cleveland Corr. Box	Cleveland	0300	9
2819	DuPont, Inc.	Cleveland	0300	10
2819	Kewanee Oil Co.	Cuyahoga Hts.	0413	11
2821	Dow Chemical Co.	Cleveland	2821	12
2821	Mobil Oil Corp.	Cleveland	0300	13
2821	SCM Corp.	Cleveland	0525	14
2851	Sherwin-Williams Co.	Bedford Hts.	0315	15
2899	Foseco, Inc.	Brook Park	0430	16
3079	Ceilcote Co., Inc.	Berea	0400	17
3312	Jones & Laughlin Steel Corp.	Cleveland	4800	18
3312	Republic Steel Corp.	Cleveland	0540	19
3312	Republic Steel Corp.	Cleveland	8100	20
3312	United States Steel Corp.	Cuyahoga Hts.	2200	21
3321	Ford Motor Co.	Brook Park	4085	22
3322	Textron Inc.,	Cleveland	0510	23
3351	Chase Brass & Copper Co.	Euclid	1200	24
3357	General Electric Co.	Euclid	0700	25
3361	Standard International Corp.	Cleveland	0700	26
3391	Park-Ohio Indust., Inc.	Cleveland	0600	27
3392	Aluminum Co. of America, Inc.	Cuyahoga Hts.	2450	28
3429	General Motors Corp.	Cleveland	3188	29
3442	Pacific Coast Co.	Walton Hills	0700	30
3452	Eaton Yale & Towne Inc.	Brooklyn	0900	31
3452	Lamson & Sessions Co.	Brooklyn	0950	32

TABLE VI

SIGNIFICANT INDUSTRIES LOCATED IN THE

THREE RIVERS WATERSHED AREA[a] (cont'd)

SIC No.	Industry	Location	Employ-ment	I.D. No.[b]
3452	Republic Steel Corp.	Cleveland	1200	33
3452	Standard Steel Co.	Cleveland	0690	34
3461	M. T. D. Products, Inc.	Parma	1200	35
3461	Ford Motor Co.	Walton Hills	4208	36
3531	White Motor Corp.	Euclid	0763	37
3537	Otis Elevator Co.	Cleveland	1100	38
3541	Acme-Cleveland Corp.	Cleveland	1918	39
3541	Warner & Swasey Co.	Cleveland	1000	40
3545	Acme-Cleveland Corp.	Cleveland	2000	41
3555	Harris-Intertype Corp.	Cuyahoga Hts.	0800	42
3559	General Electric Co.	Cleveland	0500	43
3569	North American Rockwell Corp.	Bedford Hts.	0525	44
3579	Addressograph-Multigraph Corp.	Euclid	2760	45
3613	Square D. Co.	Cleveland	0750	46
3621	Kirkwood Indust., Inc.	Cleveland	0550	47
3621	Reliance Electric Co.	Cleveland	0600	48
3621	Reliance Electric Co.	Euclid	0550	49
3621	Lear Siegler, Inc.	Maple Hts.	0798	50
3623	Lincoln Electric Co.	Euclid	1762	51
3635	General Electric Co.	E. Cleveland	0706	52
3641	General Electric Co.	Cleveland	1400	53
3641	General Electric Co.	Cleveland	1136	54
3642	Westinghouse Electric Corp.	Cleveland	0610	55
3651	Tenna Corp.	Warrnvill Hts.	0500	56
3692	Union Carbide Corp.	Cleveland	0800	57
3693	Picker Corp.	Hiland Hts.	1200	58
3694	V. L. N. Corp.	Cleveland	0629	59
3711	White Motor Corp.	Cleveland	3500	60
3712	General Motors Corp.	Euclid	1431	61
3712	T. R. W., Inc.	Independence	0573	62
3714	Abex Corp.	Bedford	0568	63
3714	Ford Motor Co.	Brook Park	2099	64
3714	Ford Motor Co.	Brook Park	3231	65
3714	Eaton, Yale & Towne, Inc.	Cleveland	1500	66
3714	Gould, Inc.	Cleveland	2142	67
3714	Midland-Ross Corp.	Cleveland	0850	68
3714	T. R. W., Inc.	Cleveland	2081	69

TABLE VI

SIGNIFICANT INDUSTRIES LOCATED IN THE

THREE RIVERS WATERSHED AREA[a] (cont'd)

SIC No.	Industry	Location	Employ-ment	I.D. No.[b]
3714	T. R. W., Inc.	Euclid	3908	70
3714	Park-Ohio Industries, Inc.	Newburgh Hts.	1000	71
3714	General Motors Corp.	Parma	8709	72
3729	Borg Warner Corp.	Bedford Hts.	0614	73
3729	Pneumo Dynamics Corp.	Cleveland	1276	74
Geauga County				
3069	Chardon Rubber Co.	Chardon	0588	75
3069	Geauga Industries Co.	Middlefield	0462	76
3069	Johnson Rubber Co.	Middlefield	0621	77
3611	API Instruments Co.	Chesterland	0742	78
Lake County				
2899	Lubrizol Corp.	Wickliffe	1023	79
3069	Eagle-Picher Industries, Inc.	Willoughby	1264	80
3481	Tyler, W.S. Inc.	Mentor	0864	81
3536	McNeil Corp., Cleveland Crane and Engineering Division	Wickliffe	0832	82
Portage County				
3079	Moore, Samuel & Co.	Mantua	0304	83
3621	Ametek, Inc.	Kent	0698	84
3732	Highway Products, Inc.	Kent	0534	85
Stark County				
3069	Monarch Rubber Co.	Hartville	1097	86
Summit County				
2026	Consolidated Foods Corp.	Cuyahoga Falls	0473	87
2822	Firestone Tire & Rubber Co.	Akron	0466	88
2822	B. F. Goodrich Co.	Akron	0305	89
3011	Firestone Tire & Rubber Co.	Akron	8041	90
3011	General Tire & Rubber Co.	Akron	3950	91

TABLE VI

SIGNIFICANT INDUSTRIES LOCATED IN THE

THREE RIVERS WATERSHED AREA[a] (cont'd)

SIC No.	Industry	Location	Employ-ment	I.D. No.[b]
3011	B. F. Goodrich Co.	Akron	8813	92
3011	Goodyear Tire & Rubber Co.	Akron	14488	93
3011	Mohawk Rubber Co.	Akron	0665	94
3031	Firestone Tire & Rubber Co.	Akron	0308	95
3461	Chrysler Corp.	Twinsburg	4725	96
3522	Massey Ferguson	Akron	0590	97
3531	General Motors Corp.	Hudson	1333	98
3559	Eagle-Picher Industries, Inc.	Akron	0655	99
3714	Goodyear Tire & Rubber Co.	Akron	0715	100
3729	Goodyear Aerospace Corp.	Akron	6748	101

[a] Industries listed had employment greater than 300 for SIC 20 to 30 and employment greater than 500 for SIC 31 to 37.

[b] Industry I.D. numbers are keyed to Figure 1.


LAKE ERIE
N
LAKEWOOD
CLEVELAND
EAST CLEVELAND
CLEVELAND HEIGHTS
SOUTH EUCLID
EUCLID
WICKLIFFE
Willowick
Willoughby
MENTOR
KIRTLAND
CHARDON
CHESTER
MUNSON
RUSSELL
NEWBURY
BURTON
AUBURN
BAINBRIDGE
AURORA
MANTUA
HIRAM
SHAKER HEIGHTS
UNIVERSITY HEIGHTS
LYNDHURST
GARFIELD HEIGHTS
MAPLE HEIGHTS
BEDFORD
PARMA
PARMA HEIGHTS
BAY VILLAGE
WESTLAKE
ROCKY RIVER
NORTH OLMSTED
OLMSTED
MIDDLEBURG HEIGHTS
COLUMBIA
STRONGSVILLE
CUYAHOGA COUNTY
LIVERPOOL
HINCKLEY
BRUNSWICK HILLS
GRANGER
YORK
MEDINA
LITCHFIELD
GRAFTON
LAFAYETTE
MONTVILLE
SHARON
RICHFIELD
BATH
SAGAMORE HILLS
TWINSBURG
STREETSBORO
SHALERSVILLE
HUDSON
BOSTON
NORTHAMPTON
FRANKLIN
RAVENNA
CUYAHOGA FALLS
AKRON
BRIMFIELD
ROOTSTOWN
SUFFIELD
RANDOLPH
SPRINGFIELD
CHAGRIN RIVER
ROCKY RIVER
CUYAHOGA RIVER
SCALE OF MILES

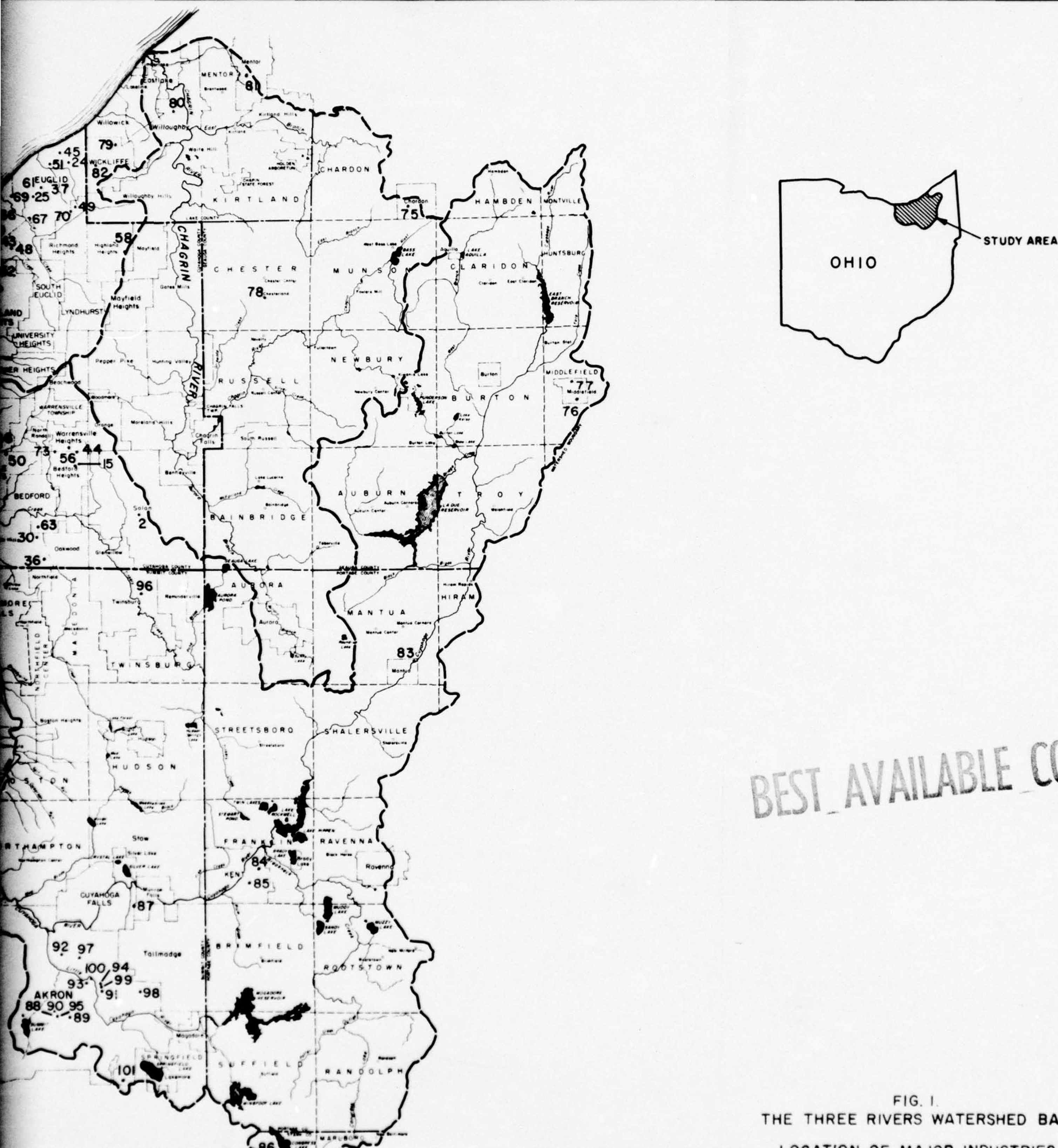


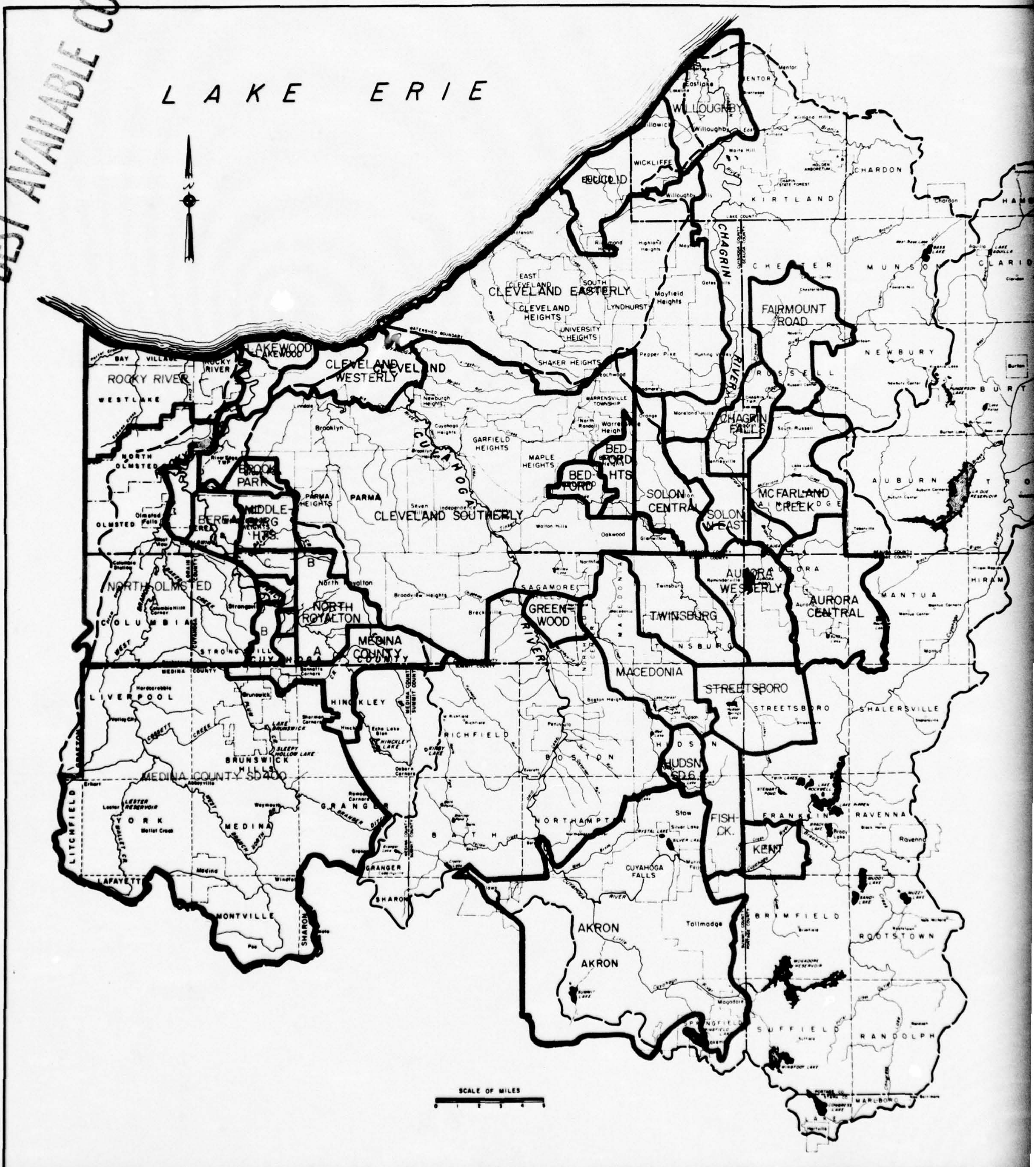
FIG. I.
THE THREE RIVERS WATERSHED BASIN
LOCATION OF MAJOR INDUSTRIES

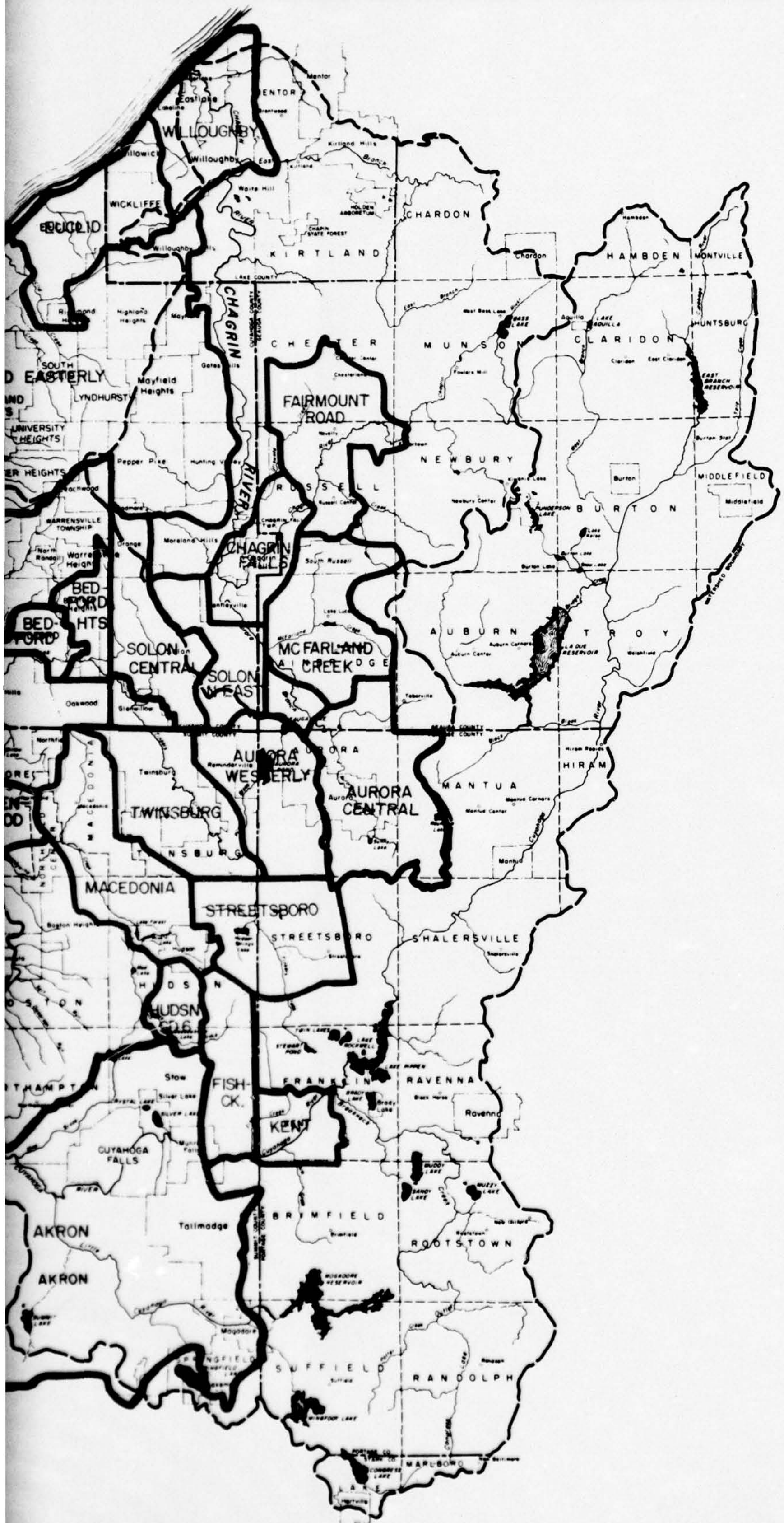
and current EPA policies which encourage combined treatment, it is expected that nearly all industries in the Study Area which are presently discharging to streams will discharge contaminated flows to municipal systems within 50 years. Of the 122 sewer districts presently in the Study Area, approximately 35 treat industrial wastewaters. Anticipated sewer district boundaries for 1980 are shown in Figure 2. Details of these treatment facilities, anticipated expansion plans, plant sizes, etc. are included in the Havens and Emerson Phase I report.

Direct Discharges to Receiving Waters

Industries discharging water or wastes to receiving waters directly through a plant outfall or through municipal storm sewers are required to apply for both state and federal discharge permits. State permit holders in the Rocky, Cuyahoga, and Chagrin river basins obtained from a 1968 report of the Ohio Department of Health [10] are shown in Attachment B. Although treatment processes provided by these industries have changed somewhat since 1968, the number of industries holding state permits have changed little since that time 12.

Information for industries which applied for discharge permits to the Corps of Engineers is presented in Attachment C. These data were summarized from information contained in permit applications supplied by the respective industries. Although several other water uses (sanitary systems, boiler feed, etc.) and other means of waste disposal


LAKE ERIE
N
WILLOUGHBY
EUCLID
WICKLIFFE
KIRTLAND
CHARDON
CHAGRIN RIVER
CLEVELAND EASTERLY
EAST CLEVELAND
SOUTH EUCLID
CLEVELAND HEIGHTS
UNIVERSITY HEIGHTS
LYNDHURST
Mayfield Heights
FAIRMOUNT ROAD
NEWBURY
SHAKER HEIGHTS
Pepper Pike
LAKEWOOD
CLEVELAND WESTERLY
CLEVELAND
ROCKY RIVER
BAY VILLAGE
WESTLAKE
NORTH OLMSTED
CHAGRIN FALLS
RUSSELL
MUNSON
BROOK PARK
BEREA
MIDDLEBURG HTS
PARMA HEIGHTS
PARMA
CLEVELAND SOUTHERLY
GARFIELD HEIGHTS
MAPLE HEIGHTS
BEDFORD
BEDFORD HTS
SOLON CENTRAL
SOLON WEST
MCFARLAND CREEK
AUBURN
OLMSTED
NORTH OLMSTED
COLUMBIA
NORTH ROYALTON
MEDINA COUNTY
SAGAMORE
GREENWOOD
RIVER
TWINSBURG
AURORA WESTERLY
AURORA CENTRAL
MANTUA
HIRAM
MACEDONIA
STREETSBORO
SHALERSVILLE
LIVERPOOL
HINCKLEY
RICHFIELD
BOSTON
HUDSN SD 6
BRUNSWICK HILLS
MEDINA COUNTY SD400
GRANGER
NORTHAMPTON
FISH CK.
FRANKLIN
RAVENNA
KENT
LITCHFIELD
YORK
MEDINA
LAFAYETTE
MONTVILLE
SHARON
BATH
CUYAHOGA FALLS
AKRON
Tallmadge
BRIMFIELD
ROOTSTOWN
SPRINGFIELD
SUFFIELD
RANDOLPH
LAKE
MARLBORO
SCALE OF MILES



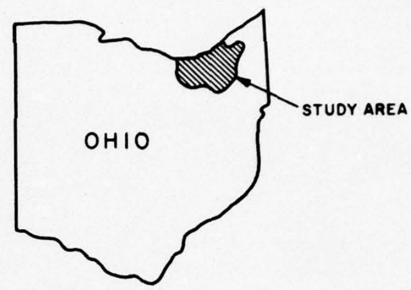


FIG. 2.
ANTICIPATED SEWER DISTRICT BOUNDARIES FOR 1980

(surface containment, underground disposal, evaporation, etc.) were identified on the applications, these were minor in most cases and were not included in this summary.

ESTIMATES OF TOTAL INDUSTRIAL WASTEWATER FLOWS

In obtaining the total industrial flow in the Study Area, several sources were consulted. Flows from each source were compared and when discrepancies arose, an attempt was made to explain and correct these differences. A summary of the flows from these various sources is presented in Table VII.

In the Alternatives for Wastewater Management report by Havens and Emerson [22], the total industrial flow to municipal sewer systems in the Study Area was given as 83.8 mgd. This total corresponds to 40.9 mgd of contaminated flow and 42.9 mgd of uncontaminated flow.

These numbers are compared to those reported in the Dalton-Dalton Study [7] for the three sewer districts in Cleveland. This study attributed 34.3 mgd of contaminated flow and 25.3 mgd uncontaminated flow to the sewer systems. Therefore, the total industrial flow for the three sewage plants in Cleveland is approximately 59.6 mgd.

Conversations with officials from the City of Akron [20] revealed that the majority of the industrial waste flow in their sewer system was attributable to 20 major industries. The total flow from these industries was approximately 20 mgd, estimated by City officials.

TABLE VII

SUMMARY OF INDUSTRIAL WASTEWATER FLOWS IN THE STUDY AREA

Reference	Point Of Discharge	Contaminated Flow (mgd)	Uncontaminated Flow (mgd)	Total (mgd)
Havens & Emerson [22]	Sewer	40.9	42.9	83.8
Dalton-Dalton [7]	Sewer	34.3	25.3	59.6[a]
Akron Officials [19]	Sewer			20
Haven & Emerson [22]	River			320.6
Dalton-Dalton [7]	River	413.3	10.9	424.2[a]
Corps of Engineers Discharge Permits	River	151.8	410.7	562.5

[a] All flows from the Cleveland steel mills were reported as contiminated discharges.

This flow together with the 59.6 mgd from the Cleveland sewer districts totals approximately 80 mgd. However, this total takes into account only 4 sewer districts, while the figure of 83.8 mgd, obtained from the Havens and Emerson data, encompasses 35 sewer districts. Also, it is not known if the 20 mgd from the Akron plant included sanitary waste flows of the industires. With the addition of the industrial flows from the remaining 31 sewer districts, the 80 mgd flow would probably be somewhat higher even if sanitary flows were subtracted from the Akron total. Thus, the total industrial waste flow discharged to city sewers is at least 84 mgd and perhaps somewhat greater.

Along with that portion of the industrial flow going to the sewer system, there is a sizeable portion discharged to the river. The data from the Dalton-Dalton study show a contaminated flow to the river of 413.3 mgd and an estimated 10.9 mgd of uncontaminated flow for a total of 424.2 mgd.

According to the Dalton-Dalton study, the steel industries contribute 402 mgd of the total 424 mgd. Several other figures for the steel industry flow were given by other sources. Data obtained from a report by Battelle Memorial Institute [4] identified a flow from the steel industires of 480 mgd of which 102 mgd was contaminated and 378 mgd was cooling water. Discharge permits obtained from the Corps of Engineers reported a total flow from the steel industries of

449.4 mgd. It was felt that the data obtained from the discharge permits were the most recent; this information was used in this reporrt. It was assumed that the steel industries could separate their flows to result in approximately 100 mgd of contaminated flow and 350 mgd of cooling water.

Additional information in regard to industrial flows to the river, which had not been elsewhere classified, was obtained from the Corps of Engineers discharge permits and the Havens and Emerson report. These flows amounted to 157.2 mgd, of which 33.1 mgd was contaminated and 124.1 mgd was uncontaminated.

Summing the above numbers gives a total flow in the Study Area of approximately 686 mgd of which 177 mgd is contaminated and 509 mgd is uncontaminated.

WASTEWATER INVENTORY RATIONALE

An inventory of existing industrial wastes produced in the Study Area was assembled for wastes treated in municipal treatment plants and for wastes discharged directly to receiving streams. The purpose of the inventory was to estimate waste loads from all significant industries in the Study Area based on data collected in previous studies and on values contained in available literature. It was desired to inventory at least 80 percent of the contaminated flow discharged by industry from processing operations. For the purposes of this inventory, industrial waste was defined to include all water discharged by industries containing contaminants other than heat. In addition, uncontaminated flows were inventoried to provide an estimate of the water required

for cooling. Industries were defined to include manufacturing industries and other establishments producing wastes having significantly greater strength than domestic wastewaters. Specifically excluded from the inventory were hospitals, water treatment plants, gasoline stations and garages, mining, and construction activities.

Sources of Data

Because existing sources of data were relied on for wastewater characteristics and flows and general industry information, i.e., products, employment and locations, it was necessary to consult a wide variety of references. The specific references which were used may be classified as relating to *general industrial information*, data collected from industries in the Study Area, and available literature. Sources which pertained to a wide variety of industries are discussed in this section. References specific to various industries are mentioned and referenced as appropriate thorughout the report.

General Industrial Information. Industries were classified according to the Standard Industrial Classification (SIC) system described in detail in the SIC Manual [23]. Data were usually described for four-digit SIC categories and tabulated by two-digit SIC categories.

The Ohio Directory of Manufacturers [21] was used as the principal source for employment figures, firm locations, and SIC classifications. The latest edition of the Directory was compiled in 1969. Although a newer edition was being prepared for publication in 1972, it was

unavailable for this study. As a means of updating information for industries in Cuyahoga County, industrial locations and employment tabulated in 1971 by the Cuyahoga County Regional Planning Commission were obtained and used in the study. Information from The Manufacturing Guide for Greater Cleveland and Northeast Ohio [24] and telephone directories was also used to verify and supplement industrial information.

Information from Past Studies. A primary source of information for wastewater volumes and pollutant loads was the Industrial Waste Survey performed by Dalton-Dalton-Little for the City of Cleveland [7]. This study included an inventory of industrial wastes in the Cleveland collection districts. Information in the survey was collected from questionnaires sent to all industries, water billing records, telephone contacts, and samples of individual insutrial effluents.

Water consumption was estimated from water department records and divided into sanitary, consumptive, contaminated, and uncontaminated uses based on information contained in questionnaires mailed to industries. Additional considerations were made for water obtained from other sources (surface waters and wells). Contaminant concentrations were assigned to industries based on the results of the sampling program and, in some cases, on values obtained from literature. In the sampling program, it was attempted to obtain samples from three industries in each four-digit category - one each from small, medium, and large firms. The data obtained in this survey were compiled in a computer printout for each sewer district with quantities of waste discharged to city sewers and receiving streams delineated.

Additional information for various industries was obtained from discharge permit applications filed with the U.S. Army Corps of Engineers and from data collected by City of Akron officials. General studies by local, state, and federal agencies were also consulted [3,4,8,9,10,22,25,26]. Most of these documents contained information concerning wastewater flows, treatment processes needed, and pollution problems of industries discharging directly to receiving waters. A report of industrial water use in Ohio [26] contained information regarding water requirements for many four-digit SIC categories.

Literature Sources. Several general sources were consulted which contained characteristics of industrial wastes and manufacturing processes [27-31]. Industry-wide wastewater surveys which were consulted included those in The Cost of Clean Water [32-37] and the EPA industrial waste profiles [39-43].

Inventory Procedure

In order to apply waste loads to all industries in the Study Area without obtaining waste volumes and pollutant loads for each firm, it was necessary to employ some readily obtainable measure of industrial activity which could be related to waste loads produced. The most common parameter used for this purpose is industrial production. The amount of product produced in a particular industry multiplied by industry-wide averages of waste loads (expressed as lb pollutant/unit of product or gal waste/unit of product) gives the

quantity of waste produced. Average waste loads or mass emission rates for many industries are available in literature sources. Waste loads are usually related to production as this parameter is most directly related to the quantity of waste produced. However, for a survey of this type in which industries included in the inventory produce an extremely wide range of products, this procedure was not feasible. In addition, production figures (or plant capacities) are not easily obtained from many industries. Production levels of industry are usually not compiled by government agencies except as the dollar value of products or value added to the economy.

A less desirable indication of wastewater production, but one which is more readily available, is industrial employment. By assuming that water use and waste production in a specific industrial category is relatively constant, values determined from a few industries in each subcategory can be applied to other industries manufacturing the same products. Because data in the Dalton-Dalton study for the City of Cleveland [7] was compiled on this basis and because of the availability of industrial employment data in the Ohio Directory of Manufacturers [21], waste loads in this study were calculated assuming constant waste production per employee for each category.

Data comprising the inventory were compiled in two ways. Existing waste volumes (mgd) and pollutant loads (lb/day) produced in the Study Area were calculated for all four-digit categories and summarized in tables for each two-digit SIC category. At the same time

portions of the waste for each four-digit category discharged to each municipal wastewater treatment facility were calculated. Using this data, tables summarizing the wastes for each four-digit category influent to each sewer district were constructed. In both sets of tables, quantities of process (contaminated) and cooling (uncontaminated) water were calculated and identified according to discharge into city sewers or to receiving streams.

The primary source of data for the inventory was that included in the Dalton-Dalton study. However, in all cases values for each four-digit SIC category were evaluated and compared to data reported in available literature. Inconsistencies were resolved by consultation with literature sources, telephone calls to specific industries in the Study Area and comparison with industrial waste characteristics encountered in other investigations.

When production figures were available, reported waste loads were compared to waste loads computed using production data and industry-wide averages for wastewater characteristics. In all cases, the most reliance was placed upon actual data obtained from the Cleveland Industrial Waste Survey [7] unless there was sufficient reason to doubt its validity. In these cases, the various other sources were used to provide a better estimate of waste loads.

In order to obtain waste loads for the entire Study Area from the Dalton-Dalton data, flows for a particular four-digit SIC category in the Study Area were calculated by applying a direct proportion between the employments of Cleveland and the Study Area to the

respective flows. Flows for individual sewer districts were obtained in the same way using employment figures for each subcategory represented in the sewer district and for the same subcategory in the Cleveland sewer distrct areas. Thus, in many cases it was assumed that water use practices and waste concentrations produced by Cleveland industries were representative of the entire Study Area. Contaminant loadings were estimated from the flow assigned to each subcategory and from contaminant concentrations estimated for each four-digit classification.

Data for industries not represented in Cleveland were obtained from various other sources. Corrections in flows estimated from employment figures were made where differences were known to exist. Most differences were identified for industries discharging to streams which had filed discharge permit applications with the Corps of Engineers. Data contained in the permit applications were generally regarded as more current than other data and were used as a source of flow data and contaminant concentrations in many cases. However, it was realized that data reported in permit applications as well as that contained in the Dalton-Dalton study were sometimes obtained from quickly designed sampling programs which may not have resulted in representative wastewater characterization.

Wastewater discharges made directly to waterways were identified primarily from information contained in the discharge permit applications. Since the filing of these permits, local regulatory officials and Corps of Engineers personnel are finding some industries which, through a misunderstanding, failed to file permit applications.

These industries are primarily ones discharging to storm sewers which they thought were connected to municipal treatment plants. However, most of these industries are quite small and the error introduced is insignificant in the inventory.

Parameters Included in the Survey. This inventory differed from most others in that raw waste loads rather than loads discharged to sewers or waterways were estimated. This was necessary as a basis for designing the industrial treatment facilities considered in the Phase II report. Because contaminant concentrations contained in the Dalton-Dalton study and those reported in Corps of Engineers permit applications were ones resulting after pretreatment, appropriate assumptions were made to estimate raw waste loads for industries which pretreat wastewaters.

Items which were not included in the inventory were flows which were recirculated and gross amounts of pollutants produced in some industries, i.e., quantities of entrails, hair, etc. produced in meat slaughtering. Flows which were identified included all process (contaminated) and cooling (uncontaminated) flow, but did not include sanitary usage.

Concentrations of pollutants attributed to each industry were concentrations above background levels in cases where the intake water had significant quantities of a particular substance. While most constituents added by a particular industry were inventoried, values for some contaminants, notably inorganic salts are not well established. It is only within the last few years with the proposal

of "no discharge" standards that many of these substances have been measured. In several cases, inorganic solids present in waste discharges were identified as total dissolved solids, but not as individual constituents since no specific data were available. In most cases, total dissolved solids were not reported if the concentration in the wastewater would not be above 500 mg/l assuming a background level of approximately 200 mg/l. This will serve to identify concentrations of pollutants which must be removed to conform to "no discharge" standards.

Industrial Categories Included in the Inventory

As a means of identifying the rationale involved in selecting industrial categories for inclusion in the inventory, a brief synopsis of the significance of each industry is included in this section. Attachment D includes detailed information concerning each industry included in the survey. To aid in assessing the significance of each industrial category in the Study Area, the reader is referred to Table V which includes a summary of employment by two-digit categories in the Study Area.

SIC 19 - Ordinance Works. Although the industries in this category produce contaminated discharges from the manufacture of munitions and artillery equipment, the industry is of little significance in the Study Area. This industry was not included in the inventory.

SIC 20 - Food and Kindred Products. Water use and contaminant loadings are characteristically high for this basic industry. It was included in the survey.

SIC 21 - Tobacco Products. No employment was reported in the Ohio Directory of Manufacturers [21] for this industry within the Study Area.

SIC 22 - Textile Products. This industry is not a large one in the Study Area. However, waste loads were significant enough that this category was inventoried.

SIC 23 - Finished Fabric Products. Industries in this category within the Study Area use very little, if any, water for manufacturig processes.

SIC 24 - Lumber and Wood Products. No process water of significance is used by these companies.

SIC 25 - Furniture and Fixtures. Most subcategories use no process water. Cooling water is used in some firms producing metal furniture. This category was not included in the inventory.

SIC 26 - Paper Products. Most firms in the Study Area do not produce contaminated discharges. However, wastes from some segments of the industry were significant and were included in the inventory.

SIC 27 - Printing and Publishing. The major water use in this category is for air conditioning and cooling of linotype machines. Conversations with several printers confirmed these observations. Although 1.1 mgd of cooling water use in this industry was identified

i.. the Dalton-Dalton survey, the industry is not significant with respect to wastewater problems and was not included.

SIC 28 - Chemicals. A wide variety of contaminants are produced in this industry. It was included in the inventory.

SIC 29 - Petroleum Products. Although not a large industry in the Study Area, wastes from this industry may be significant because of oil pollution problems in the Three Rivers Watershed area. The category was included in the inventory.

SIC 30 - Rubber and Plastic Products. This industry is significant, especially in the Akron area, and was inventoried.

SIC 31 - Leather Products. This Industry is very small. Leather products firms in the Study Area use only dry manufacturing processes.

SIC 32 - Stone, Clay, Glass, and Concrete. Discharges from this industry contain predominantly inorganic solids. Although 2.6 mgd of water is used by this industry in Cleveland, pollution problems are not great in many cases. The industry was not inventoried.

SIC 33 - Primary Metals. This category includes the steel mills in Cleveland and is of great significance in the Study Area. It was included in the survey.

SIC 34-37 - Fabricated Metals Industries. A great number of these industries are located in the Study Area. Discharges contain significant amounts of metals and oil and were included in the survey.

SIC 38 - Scientific Instruments. The majority of these companies have a very low water consumption and were not inventoried.

SIC 39 - Miscellaneous Manufacturing Industries. Although this industry is very diverse, waste discharges were not found. The industry was not included in the inventory.

SIC 72, 75 - Cleaning Establishments. Wastes from laundries and car washes were inventoried because of their organic and oil loadings.

DISCUSSION

Existing industrial waste loads for the Study Area are identified by four-digit SIC categories in Attachment E and by sewer districts in Attachment F. A summary of these loads by two-digit SIC categories is presented in Table VIII. The total industrial waste flow for the Study Area was 670.2 mgd which compares to 690 mgd estimated from previous studies to be the total industrial waste discharged in the Study Area.

The total process flow identified in this survey was 164 mgd or approximately 24 percent of the total estimated waste flow. The total cooling water usage was estimated to be 507 mgd.

The most significant industries not included in this inventory were the printing industry, SIC 27, and stone, clay, glass, and concrete products, SIC 32. Discharges for SIC 27 included in the Dalton-Dalton study were 1.03 mgd uncontaminated and 0.031 mgd contaminated flow. All contaminated flows came from lithographing establishments, SIC 2752. Discharges in SIC 32 totaled 0.30 mgd uncontaminated and 2.32 mgd contaminated flow. Contaminated

TABLE VIII

SUMMARY OF EXISTING INDUSTRIAL WASTE LOADS BY INDUSTRIAL CATEGORY

SIC No.	Wastewater Flow (mgd) City Process[a]	City Cooling[b]	Stream Process[a]	Stream Cooling[b]	Contaminant Loads (lbs/day) BOD	COD	SS	TDS	Alk	Acidity	Oil	TKN	P
20	8.305	1.574	1.891	0.609	175,705	390,808	87,779	201,395	-	-	3,685	7,218	3,613
22	0.601	0.074	-	-	2,272	9,102	944	9,707	-	-	-	16	40
26[c]	0.014	0.48	1.8	0.14	500	2,000	1,251		-	-	-	38	-
28	1.22	0.223	2.425	5.463	3,067	8,948	21,984	41,933	-	-	372	1,852	6
29	0.245	1.053	0.43	0.103	175	811	612	8,449	-	-	234	-	10
30	14.17	1.725	8.4	83.71	15,979	96,200	28,326	186,900	-	-	1,600	-	-
33	9.51	9.104	81.0	378.5	56,826	172,705	2,092,085	87,289	-	35,350	101,003	8,563	246
34	13.73	6.47	1.518	0.106	-	1,541	29,307	128,988	26,191	-	8,957	-	-
35	1.46	4.746	-	0.015	-	-	4,113	86,316	7,909	-	4,234	-	-
36	1.793	5.37	0.182	0.01	-	-	1,055	17,223	2,673		671	-	-
37	2.635	7.678	1,507	-	-	-	5,196	18,971	5,163	-	2,089	-	300
72,75	8.836	-	-	-	13.161	35.091	18.178	48.201	20.032		852	512	654
Total	62.52	38.50	99.15	468.66	264,685	717,206	2,290,830	835,352	61,968	35,350	123,677	18,199	4,869

[a] Includes all contaminated discharges from manufacturing processes.

[b] Includes only uncontaminated cooling flow.

[c] Inventory includes only waste discharged by major manufacturers.

TABLE VIII (cont'd)

SUMMARY OF EXISTING INDUSTRIAL WASTE LOADS BY INDUSTRIAL CATEGORY (cont'd)

SIC No.	Contaminant Loads (lbs/day) SO_4[d]	Cl[d]	F	CN	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Sn	Al	Mn
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	2,180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	2,816	213	-	-	-	3.2	29.8	4.1	6.9	1.5	1,915	34	-	44	-
29	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	23,530	92,410	780	408	455	-	158.8	286.5	403.5	206.8	333.4	2,070	377,956	-	-	-
34	-	-	-	1,855	-	20.4	1482	1426	68.4	1706	32.1	1,126	6,935	-	-	-
35	-	-	-	20	-	-	72.9	73.4	2.7	54.4	-	42.2	46.4	-	-	-
36	-	-	-	0.3	-	-	8	103	5.5	28.1	-	33.1	93	-	-	-
37	-	-	-	9	-	-	30.1	30.1	2.2	46.1	-	27.3	33	41	39.5	46
72,75	-	-	-													
Total	25,710	95,226	993	2,292	457	20.4	1,755	1,949	486.4	2,048	367.0	5,214	385,097	41	83.5	46

[d] Substances were incompletely inventoried due to lack of data. Only major sources are included.

discharges came primarily from SIC 3269 pottery manufacturing. Pollutants were usually limited to alkalinity and suspended and dissolved solids. Employment in these industries in Cleveland was approximately 85 percent of the Study Area total for SIC 27 and 55 percent for SIC 32. Flows in these two industries were less than one percent of the total industrial waste flow in the Study Area.

Because of the great diversity of the chemical industry, even among four-digit SIC categories, only selected parts of the industry were inventoried. Included in this survey were the larger manufacturers of organic and inorganic chemicals (SIC 281), producers of primary rubber products (SIC 282), and paint and varnish manufacturers (SIC 285). The total flow from these categories was 18.4 mgd. The total flow from the chemical industry identified by Havens and Emerson [22] was approximately 30 mgd. Thus, the flow omitted is approximately 2 percent of the total industrial waste discharge.

A significant portion of the oxygen demand produced by industry comes from SIC 20, food products; SIC 30, rubber and plastics products; and SIC 33, primary metals. A significant portion of the BOD and COD contained in steel mill effluents is due to the oxidation of iron from the ferrous to the ferric state and does not represent an organic load. However, the oxygen demand could have an effect on the receiving water. A major portion of the heavy metals contained in wastewaters were contributed by SIC 34, the fabricated metals industry, and SIC 33, primary metals. The plating industry, SIC 3471, is the source of the majority of these metals.

Waste flows and pollutant loads contained in this inventory do not include sanitary waste discharged by industry. Although sanitary discharges from industries will vary according to the number of industries having cafeterias, shower facilities, etc., an estimate may be made to indicate the magnitude of this contribution. Assuming that an average of 35 gpd/employee of sanitary wastes is discharged, the total industrial sanitary waste flow in the Study Area is 13.5 mgd. Applying BOD and suspended solids concentrations of 200 mg/l each to this flow, the contaminant load from sanitary wastes is 22,450 lb/day for both BOD and suspended solids. This load is approximately eight percent of the total BOD raw waste load. When the suspended solids concentration of the iron and steel industry is excluded, suspended solids from sanitary wastes are approximately seven percent of the total.

Because the quantities of waste included in this inventory were raw waste loads, the quantities listed in Table VIII would not be discharged to city sewers or to receiving streams. Treatment by industry will result in significant reductions in some wastes, especially BOD, COD, suspended solids, oil, and heavy metals.

Water Use in the Power Industry

Although electric power plants were not included in this inventory, the quantities of water used in this industry are large and should be mentioned. Four power plants are presently located in the Study Area. These include the East Lake and Lake

Shore plants owned by Cleveland Electric Illuminating, the Cleveland Municipal Light Plant, and the Gorge Plant operated by Ohio Edison. According to discharge permit applications filed by these plants, water use in 1971 totaled 1,449 mgd for cooling, 0.3 mgd for boiler makeup, 27 mgd for general service, and 3.4 mgd for ash sluicing.

From conversations with the companies it was determined that no new plants are planned for the Three Rivers Watershed area in the forseeable future. New plants will most likely be nuclear-fueled facilities which will be located along Lake Erie in sparsely populated areas. It is anticipated that the plants presently located in the Study Area will be used only for peaking purposes beginning at various dates from 1990-2020 for the respective plants. Therefore, the water use for these plants will decline in the period to 2020. The only anticipated increases in capacity is planned for the Cleveland Municipal Plant before 1990. Estimates of total water requirements for these plants is summarized for the period 1990-2020 in Table IX.

Compatability of Wastes with Municipal Systems

In identifying appropriate methods for the treatment and disposal of industrial wastes, the compatability of various wastes with municipal treatment facilities must be determined. The discharge of toxic substances to city sewers may upset treatment processes and result in the discharge of wastewater which does not

TABLE IX

WATER USE BY THE POWER INDUSTRY[a]

Year	1972	1990	2000	2010	2020
Water Use (mgd)	1478	1307	1025	843	649

[a] Includes water use for cooling, boiler feed, general service, and ash sluicing.

meet receiving water quality standards. Large amounts of suspended solids, oil, and greases can not only result in mechanical failure of treatment processing equipment but, more significantly, might interfere with biological treatment of the combined wastestreams.

In most cases, a substance is defined as incompatible with municipal treatment facilities if: 1) it causes damage to treatment processes or harm to treatment plant personnel, or 2) it passes through the treatment processes and is not reduced to sufficient levels to meet established water quality criteria. From this definition, incompatability of wastestreams may change for different water quality standards. For instance a high strength nitrogen waste may be compatible with municipal treatment if nitrogen presents no problem in the receiving water. In the event that nitrogen limitations were imposed, the waste would require pretreatment if the municipal facility did not add a nitrogen removal process. Other constituents to which the same reasoning applies include total dissolved solids, phosphates, etc.

Wastes which are noncompatible with municipal treatment processes may further be divided into wastes which can be made compatible with proper pretreatment and wastes which are completely noncompatible with municipal treatment processes. Thus, three types of wastes may be identified: wastes which are compatible with municipal treatment systems; wastes which are compatible after

appropriate pretreatment ; and, noncompatible wastes. It is implied in these distinctions that wastes made compatible by proper pretreatment will require further treatment before they are acceptable for discharge to receiving waters, while noncompatible wastes, after treatment in special facilities will meet water quality standards. In actuality the degree of treatment of wastes provided by industry may depend as much on the location of the industry with respect to city sewers and receiving waters as on the characteristics of the waste.

Wastes from specific industries which must be pretreated before discharge to municipal sewers are listed in Table X. It is expected that wastes from the chemical industry and steel mills will continue to be treated by industry in the future and discharged directly to receiving waters when possible. The degree of pretreatment required of these wastes for discharge to municipal systems often is also sufficient for discharge directly to receiving waters. Complete treatment of most steel mill wastes by industry is likely to continue because of specialized treatment requirements and because of the volume of these wastes.

Wastes which must be pretreated prior to discharge to municipal systems include wastes in the primary metals industry other than steel mill wastes, rubber industry wastes, and wastes from fabricated metals industries (SIC 34-37). However, wastes from these industries will require pretreatment only when the critical

TABLE X

MAJOR WASTES REQUIRING TREATMENT

IN SEPARATE FACILITIES

Industry	Noncompatible Constituents
Chemicals	Some dissolved organic and inorganic solids, suspended solids, heavy metals, phenols, and other constituents depending on specific manufacturing processes involved
Petroleum products	Oil
Rubber products	Suspended solids, possibly toxic organic compounds
Primary metals	Cyanides, high concentrations of ammonia, large quantities of suspended solids, oil, heavy metals, phenols
Primary metals, fabricated metal products, machinery, transportation equipment	Heavy metals, oil, pickle and bright-dip rinses, cyanides

constituents listed in Table X are present in the wastestream. These categories can be determined by referring to wastewater characteristics for the various industries included in Attachment D.

In addition to the wastes listed in Table X, minor quantities of wastes in other industries must be pretreated in some cases. However, the quantity of these wastes is of no great significance in a survey of this type. These wastes will include photographic chemicals discharged from printing establishments, solvents from various sources, cleaning solutions, etc. While high strength organic wastes from food products industries, chemical industries, paper mills, etc., may sometimes be treated separately by the industry, most of these industries in the Study Area are located in sewer districts which are capable of handling these loads. In some instances paper mills in the Study Area may continue to treat wastes which could be handled in municipal systems because of the quantity of flow involved and because of the location of some mills.

FUTURE INDUSTRIAL WASTE LOADS

Projections of industrial waste loads were based principally on anticipated changes in industrial employment and on water use patterns. Specifically, the following factors were included in this analysis:

1. Projections of industrial employment.
2. Changes in the level of manufacturing technology as they relate to water requirements and quantities of waste produced.
3. Waste reduction practices which could be implemented without extensive plant modifications.
4. Changes in worker productivity.

POPULATION AND EMPLOYMENT GROWTH

Because projections of population growth and industrial employment are more easily obtained than estimates of industrial output, they were used as an indicator of industrial growth in the Study Area. Estimates were based on economic and demographic projections of Northeast Ohio developed by Battelle Memorial Institute for the Northeast Ohio Water Development Plan [52]. Included in this study was the Three Rivers Watershed Area encompassing the counties of Cuyahoga, Geauga, Medina, Portage, Summit, and small sections of Stark and Lorain. After reviewing the projections for these counties, it was felt that these were the most accurate data available and was used in this study.

Projections used in the Battelle model were based on both demographic factors relating birth, death, and migration in individual counties and communities, and economic factors dealing with employment, unemployment, and the size of the available labor force affecting the structure of major industrial classifications.

Projections in the Battelle study were derived from a computerized simulation model of the regional economy of Northeast Ohio. The region was divided into five major labor market areas or subregions. Two of these subregions - the Cleveland and Akron labor markets - contained information relevant to this investigation. The Cleveland subregion included Cuyahoga, Medina, Lake, and Geauga Counties; and the Akron subregion included Portage and Summit counties. Small portions of Lorain and Stark counties were also included in the Study Area; however, no industry in these counties discharges waste to the Three Rivers Watershed area.

Since World War II, population in the Study Area has increased from 2,585,000 in 1940 to 3,012,000 in 1960. Because of the strong, diverse industrial base, the Study Area prospered during the 1940's and in the early part of the 1950's. However, due to national fiscal cutbacks and technology changes, this growth rate began to decline in the late 1950's. During the period between 1940 and 1950, total employment in the six counties in the Study Area increased at an average annual rate of 3.0 percent. Between 1950 and 1960, this rate declined to 1.5 percent per year and eventually to 0.4 percent between 1960 and 1970. The employment

in the six counties in 1970 totaled 1,459,164 persons. It is expected that the annual growth rate will average 0.7 percent per year during the 50 year projection period. This will bring the total number of employees in the six country area to 2,080,000 persons in 2020. Currently, the majority of the population in the Study Area is located in the urban areas of Akron and Cleveland. This increase in population during the next 50 years will result in increases in the density of existing communities and the building of new communities bewteen the major cities.

This growth will not be affected equally among all industries. Employment in manufacturing industries is expected to increase 19.3 percent during the period between 1970 and 2020. This is an average annual growth rate of 0.3 percent per year which is one-half of the rate of the previous three decades. It is expected that the majority of the growth will occur in the Cleveland and Akron areas. Growth in the Cleveland subregion will be approximately 88,000 persons, whereas the growth in the Akron subregion will be 31,000 persons. Unemployment in the six counties is expected to increase from less than 4 percent in 1970 to 9.4 percent in 2020.

The employment projections for the Study Area are identified by two-digit SIC categories according to county and are presented in Attachment G. To project industrial growth, multipliers were obtained from these tables using 1970 as the base year. A

separate multiplier was obtained for each two-digit SIC number for every 10-yr period for each county.

CHANGES IN WATER USE PATTERNS

Levels of technology and wastes produced for each level were identified for several industries in The Cost of Clean Water Series [32-37]. Production methods identified in these studies were classified as old, typical, or advanced processes. These various levels of technology are generally classified as to the relative prevalence of certain subprocesses in a particular plant. Generally, as the technology proceeds from old to advanced, the subprocesses become more automated and efficient.

Projections were made of expected changes from older to newer technology for the period 1963-1980. For this study, estimated changes in technology were extrapolated from 1980 to 2020 so that all processing by 2020 was with advanced technology. Industries examined included food products, paper mills, textile products, and blast furnaces and steel mills. Estimated changes in technological levels were different for each industry since the base of thse projections was the level of technology for each industry at the present time. For each decade, the number of plants using each level of technology was expressed as a percentage of the total number of plants in the industry.

Waste loads and volumes for each level of technology in the various industries were applied to the process mixes for each

decade. The resulting figures, which represented an average pollutant load in lb/tn or gal/tn for the process mixes of each industry, were normalized with respect to the loads produced in 1970. The resulting numbers were used as multipliers for estimated increases in waste loads for the period 1970-2020. Separate multipliers were calculated for waste volumes and the quantity of contaminants produced since these will vary independently as technology levels change. Trends in the quantity of pollutants produced for the various industries were examined individually. However, changes in loads of individual pollutants were relatively constant with respect to each other. Thus, if the pounds of BOD per ton of paper decreased with increasing levels of technology, the amounts of other pollutants decreased in roughly the same ratio as the decrease in BOD.

Upon examining waste production practices in the various industries, it became apparent that future trends should be separated into two broad industrial categories. In all industries except the steel industry, waste volumes and constituent loadings decreased with the adoption of newer technology. This decrease in waste load is to be expected because improved waste reduction practices, such as recirculation of process water, chemical recovery, and product recovery, are incorporated directly into the manufacturing process as the newer technologies are employed. However, in the steel and fabricated metals industries waste loads per unit of product increased with newer technology.

This increase in waste load with advancing technology can be attributed to several factors. Older processes employ fewer intermediate finishing operations and consequently produce smaller quantities of finishing wastes from gas scrubbing operations. Another factor to be considered is that the trend in the newer mills is toward lighter gauge products. In rolling, plating, casting, painting, and other operations associated with metal fabrication, waste production is more a function of product surface area than of the weight of product produced. Variations in pollutant loads and waste flows are shown relative to 1970 levels in Figures 3 and 4.

In addition to changes in technology, allowance was made for in-house efforts by industry to minimize water use and product spills. It is expected that these changes will be encouraged by industrial management as the cost of water and wastewater treatment increases. Values were taken largely from a study [44] in which several waste abatement programs from various industries were analyzed. These programs indicated that education and in-plant changes could account for approximately a 14 percent decrease in waste loads. It was assumed that these changes would be fully implemented by the year 1990 and that no additional decreases due to these factors would be noted after that year. To take into account this decrease in waste load brought about by education and in-plant changes, the previously obtained multipliers were adjusted accordingly.

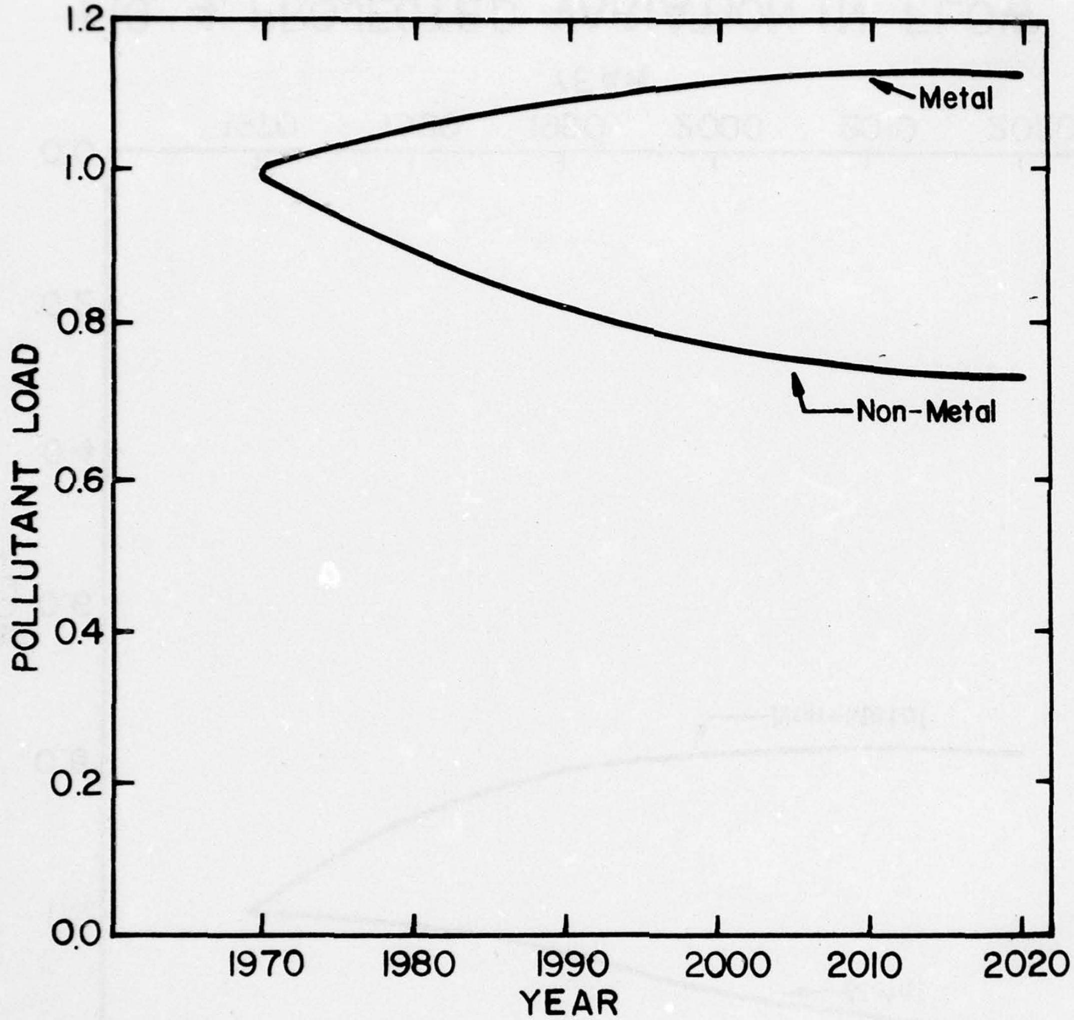


FIG. 3. PROJECTED VARIATION OF POLLUTANT LOADS

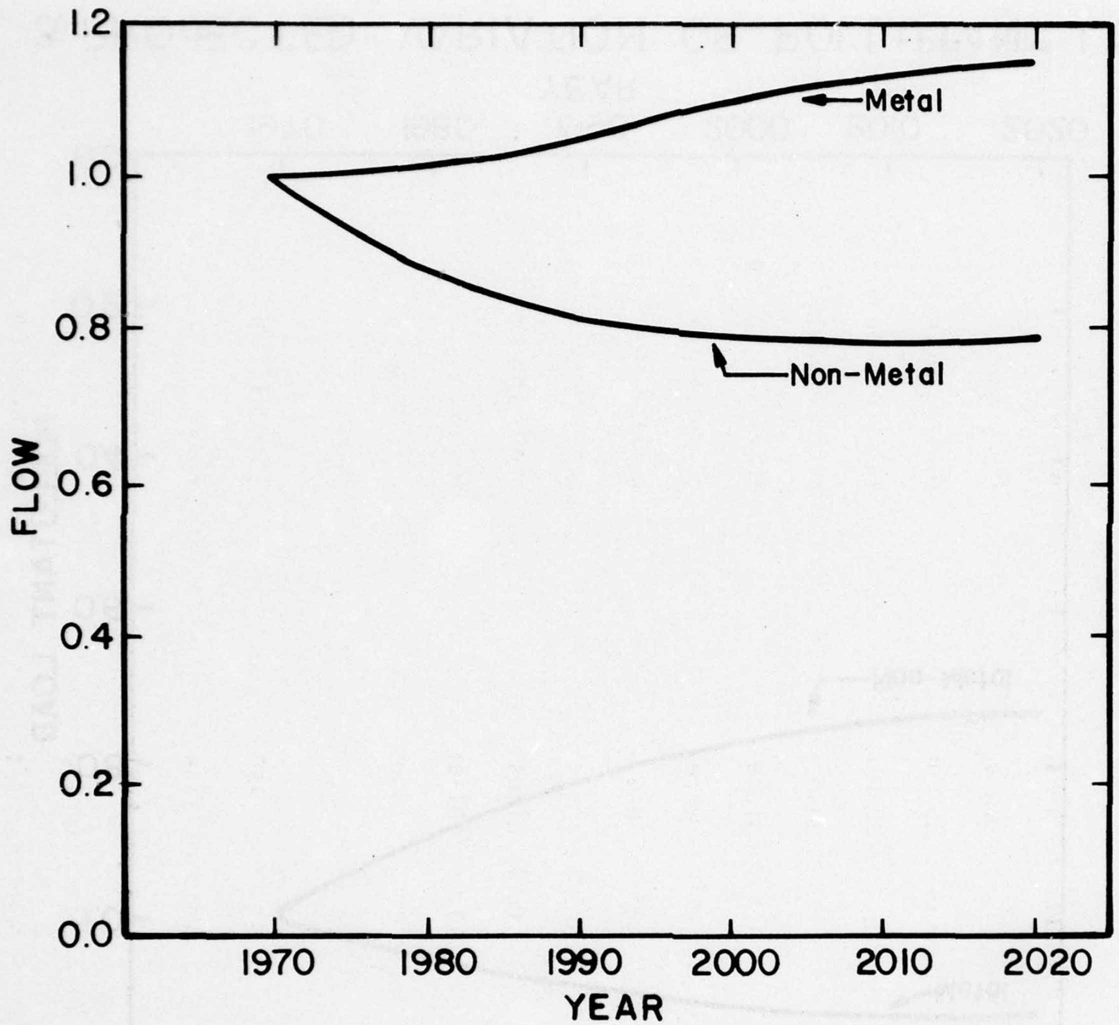


FIG. 4. PROJECTED VARIATION IN FLOW

Changes in productivity were accounted for by assuming that compared to a base value of 100 man hr/tn product using old technologies, only 85 man hr/tn would be required using typical technology and 70 man hr/tn for advanced technology. It should be noted that these values are relative to technological levels and are not absolute measures of productivity. However, only relative values were required to project waste loads from 1970 base values. These values were corrected for the process technology mix anticipated for each decade, normalized with respect to 1970 values, and incorporated into the employment and waste load multipliers. These multipliers were then used to project further industrial waste loads. Estimates of future wastewater loads are presented in Attachment H.

WASTEWATER LOADS AND FLOWS DISCHARGED TO MUNICIPAL SEWER SYSTEMS

Industrial flows and metal loads which would be discharged to municipal sewer systems after pretreatment by industry are identified in Attachment J. Metal loads which would be discharged after pretreatment for Alternatives 1, 2, and 5 are given for present wastewater loadings and for projected conditions in 1990 and 2020. Industrial wastewater discharges to municipal sewer systems for Alternative 1 and 3 and for Alternative 2 are also identified. Treatment alternatives are identified in the Phase II report.

INDUSTRIAL WATER REQUIREMENTS

Water reuse is becoming attractive to industries as increasingly stringent discharge requirements are enforced. Unfortunately, recycling incentives are not well established. Current industrial water usage management programs necessitate implementing plans to optimize water usage in relation to raw water availability (quality and quantity), product quality requirements, processing alternatives, waste treatment considerations and overall system flexibility.

The following discussion delineates the source of various process and cooling water wastestreams for selected industries that are significant in the Study Area. Discussions include summaries of current water usage in manufacturing processes and alternative water use practices.

The food and kindred products industry includes a wide variety of operations in the Study Area. Most plants in this industry are required to strictly adhere to sanitation and housekeeping requirements which usually necessitate the use of a fresh water supply for many process purposes. In some cases it may be acceptable to use contaminated waters for initial rinsings and cleanup. Specific industries in the SIC 20 category that have significant discharges are individually discussed below.

Fluid milk, SIC 2026, has a relatively significant process waste stream due to spillage and wastage of whole and separated milks, buttermilks, and whey, as well as required washing of butter and cheeses. Equipment and general cleanup operations also contribute to the effluent process waste stream. Typically, rinse water is being reused several times for the preliminary rinsing of the fluid milk delivery tanks. Spent uncontaminated waters originate in the condensing refrigeration systems and various pre-cooling operations e. g., milk coolers, vat pasteurizers and air-conditioning systems. These spent uncontaminated waters are sometimes recycled.

Bread and bakery products industries, SEC 2051, have significant waste sources due to the high organic content of the raw materials used. Typically, the majority of the process wastestream contamination is not due to bread production since this is largely a dry process, but where bakeries are sweeping and vacuuming bread crumbs and spills for by-product sale. The production of doughnuts, pies, and various pastries is the major source of process water contaminants. Very little cooling water is used other than that required for refrigeration and air conditioning.

The malt liquor industry, SIC 2082, has the largest SIC 20 process discharge in the Study Area. Considerable wastewater is generated

in the malt liquor brewhouse, fermination-filtration cellar, and the packaging areas. Cooling water is used in a variety of heat exchangers and refrigeration operations. Process water is discharged from essentially every unit operation in the malt liquor manufacturing process. Breweries vary significantly in their normal production procedures depending on size and level of techonology of the plant. Reuse of process rinse water is being used in initial equipment cleanup operations. Cooling water is frequently countercurrently recirculated in bottling and pasteurizing operations.

The chemical and allied products industries discharge approximately 8.8 and 9.6 mgd of process and cooling water, respectively. The primary sources of major process wastewaters in the SIC 28 industries are as follows [42]:

1. Brines from crystallization and electrolysis processes.
2. Filter cake backwashings.
3. Spent acids and alkalines.
4. Washing operations.

Primary cooling water and steam condensates are the major sources of the uncontaminated discharge. Potential sources of contamination of the cooling water are from process leaks, boiler blowdown and waste condensate. Recycling of much of the cooling water flow is now being accomplished within chemicals industries.

The rubber and miscellaneous plastic products industry discharges approximately 24.3 and 86 mgd of process and cooling waste-

waters, respectively. Cooling water is extensively used in the initial mixing and blending of the raw materials. Cooling water is also used in the various milling and extrusion operations. The process wastewater is generated during the rubber slab quenching process and steam curing of green tires. Water is currently being reused in the rubber quenching operation. Considerable suspended solids are discharged to the process wastestream from the processing of white-walled tires. Suspended solids can be partially eliminated from the process wastestream by using dry methods, e. g., sweeping and vacuuming rather than wet cleanup operations.

Water use by the steel industry in Cleveland was estimated to be approximately 450 mgd. If process and cooling flows were separated, the contaminated flow would be approximately 180 mgd with the remaining 350 mgd being discharged as uncontaminated cooling flow. While it would be possible to reuse the uncontaminated cooling water, the incentive required to install cooling towers would probably not be present until the cost of water increases significantly.

While water reuse is practiced in some parts of the Cleveland mills at the present time, the extent of reuse is expected to increase in the future. At the present time water for hot rolling operations is treated and reused, thus producing savings in waste treatment costs. Also, benzol plant effluent is recirculated for use in coke quenching. One consideration which may limit this practice in the future is the stripping and oxidation of volatile substances which contribute to air pollution problems in congested areas.

Gas washer water from blast furnaces may be recirculated after chemical treatment to reduce suspended solids concentrations to acceptable levels. Various sources of water within a mill may be reused following cooling. However, air pollution considerations may again limit the applicability of this practice in situations where volatile matter is stripped from the water. Even though water recycling procedures are being implemented by the steel industry, water use is not likely to decrease. In some cases, advanced technology will require greater water volumes per unit of production than conventional technology. The tendency toward the use of lighter gauge steel in fabricated steel products results in increased water usage in rolling mills and in subsequent metal finishing processes.

The fabricated metal products, except ordinance, machinery and transportation equipment industry, SIC 34, is a very significant industry in the Study Area. The process discharge from this industry is second only to the rubber industry, SIC 30.

In the fabricated metals industry the largest process water discharges come from electroplating, SIC 3471, and from the manufacture of nuts and bolts, SIC 3452. The daily process discharges from these industries are estimated to be 4.57 and 3.66 mgd, respectively. The metal stamping industry, SIC 3461, discharges daily approximately 48 percent of the total SIC 34 cooling water in the Study Area.

Specifically, the sources of wastewater in the electroplating and metal finishing industry are as follows [51]:

1. Rinses from cleaning and finishing.
2. Concentrated baths periodically wasted or accidentally spilled.
3. Water used in various cleanup operations.
4. Sludges and filter cakes generated in plating and rinsing baths.
5. Regenerants from ion exchangers.
6. Vent scrubber wastewaters.

Large amounts of water are required in most metal finishing operations for intermittent rinsings. However, the overall water usage can be optimized by implementing current water handling methods to provide for reduction in contaminant levels and substantial reductions in the daily process water discharges. Recycling of rinsewater necessitates a well-defined effluent segregation program, since it is commonly necessary to treat rinse waters before extensive reuse. Water systems can be designed to provide hydraulic plug flow countercurrent rinsing by proper placement of inlets and outlets devices and placement of variable baffling. Product conveyer systems can be designed to produce minimum drag-out by appropriate draining, the installation of drip boards and drainage tanks, air blowing or inducement of mechanical vibrations. Steps can be taken to minimize the risk of leaks, overflows and accidental spills by providing impoundments designed specifically to receive these problem wastes.

Stamping plants generate relatively small amounts of process wastewater. Processing water appears to be relatively independent of plant size [33]. For example, an average size stamping plant discharges between 0.002

to 0.01 mgd of contaminated process water. A wash water is generated during the metal curing operation. The metal pressing process contributes oil and metals to the process wastestream. Large amounts of cooling water are used in welding operations. The average stamping plant [33] with a typical cooling water recirculation with blowdown system discharges between 0.036 and 0.288 mgd. Since major recirculation of cooling water is practiced in stamping plants, cooling water discharges are primarily due to blowdown from these systems. In some stamping plants, the major cooling water contaminants are due to boiler house blowdowns.

Waste discharges from the manufacture of motor vehicles and aircraft parts is approximately 75 percent cooling water. Since these industries include a multiplicity of operations, a separation has been drawn [33] to classify processing operations by their discharge of oil-contaminated and minimal oil contaminated wastewaters. The sources of oil contaminated discharges are from machining and die casting operations. Sources of minimal oil contamination are generated during casting and radiator manufacturing.

Oil in a machining operation is discharged to the wastestream by cleaning operations, spillage, and intermittent wasting of recirculating coolant systems. Die casting operations generate a significant oil contaminated wastestream by cooling the molded product in a water quench pit. During subsequent casting, deburring, and buffing operations, wet air

scrubbers contribute suspended solids and metals to the process wastestream. Quenching and scrubber waters are commonly recycled but must have periodic dumping or blowdown.

Non-oil contaminated wastestreams are generated in the cleaning of sand molded pieces by hydraulic scouring. An alternative method being used is to air scour instead of using the wet system. Significant heavy metal wastestreams can be generated from several operations in the SIC 37 category e. g., plating operations as well as radiators and battery manufacturing.

TREATMENT OF WASTES IN COMBINED INDUSTRIAL FACILITIES

In addition to treatment of wastes by individual industries or in municipal systems, it might be desirable to treat wastes from several industries in special industrial waste facilities. Advantage might be taken of differences in wastewater characteristics from adjacent industries. Acids and alkalis resulting from different firms could be neutralized in a central treatment facility, thus, saving both industries the cost of chemicals required for separate facilities. At the same time, the dissolved solids load to receiving waters would be minimized. Other examples of treatment which might be considered for a facility of this type are combined treatment of spent pickle liquors and phosphate cleaning solutions, biological treatment of high strength organic wastes, and treatment of wastes containing toxicants such as cyanide or heavy metals.

The purpose of this chapter is to identify wastes which demonstrate the potential for treatment within combined treatment facilities and to discuss the feasibility of implementing selected plans. Before specific projects are discussed, the advantages and disadvantages of combined treatment in industrial facilities will be identified to add perspective to the problem.

ASPECTS OF COMBINED INDUSTRIAL TREATMENT

Financing

In the State of Ohio, a method of financing for industrial waste treatment facilities is afforded through powers given to the Ohio Water Development Authority. Financing by the sale of revenue bonds through the OWDA is available for pollution abatement projects of individual industries or through facilities being constructed for the treatment of waste from several industries. Usual procedure has been for the individual industry to operate and maintain facilities constructed with OWDA funds. However, in the case of combined treatment facilities for several industries, it would be possible to finance construction of pollution abatement facilities through OWDA funds and to form a separate sewer authority responsible for operation and maintenance of these facilities. Industries involved would pay waste treatment charges to the sewer authority for operation and maintenance and amortization charges. Further details of financing available through the Ohio Water Development Authority are discussed in Chapter II, Industrial Wastewater Management in the Three Rivers Watershed Area.

Advantages and Disadvantages of Combined Treatment by Industry

Assuming that any complications arising from financing arrangements can be overcome, several other factors must be considered in determining

the feasibility of combined treatment. The significant consideration for any industry considering combined waste treatment with other industries will be the estimated cost of this type of treatment compared with other alternatives. In many cases, savings both in capital and operating and maintenance expenses can be minimized by taking advantages of economies of scale inherent to larger treatment systems. In addition, operation of larger scale facilities enable the hiring of more competent and capable technical personnel to oversee the operation of these facilities. This factor can be of great significance in the operation of industrial treatment facilities in which more sophisticated treatment processes would be required. The additional cost restraint which must be considered is the cost of transporting waste to the treatment facility. While in the case of some industries which are located adjacent to each other, it may be possible to use a trunk line of the city sewer system to transport wastes to the treatment facility, new sewer lines will be needed in many cases. Cost for the construction of new sewer lines, including the expense of purchasing right-of-way, may overshadow the advantages of combined industrial treatment in some instances.

The performance of treatment facilities may be affected either favorably or unfavorably in combined facilities. Because large treatment facilities are more capable of absorbing and teating major fluctuations in waste strength and changes of constituents present in waste streams, combined systems containing biological treatment processes will tend to

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perform better than separate treatment processes. In addition, mixed wastestreams are often more treatable than individual wastes. The treatment of nutrient deficient waste streams will be facilitated in combined biological systems if a waste containing excessive nutrients is also discharged to the system. Neutralization of waste streams in combined systems can be handled effectively if the proper quantities of acid and alkaline substances are present in the influent waste. Also, synergistic effects of aluminum, iron, and phosphates may be utilized for phosphorus removal in combined systems.

Problems may be encountered in maintaining adequate levels of treatment in combined treatment facilities if proper communication between the treatment facility and industry is not sustained. Use of the system as an industrial dumping ground would make proper operation of treatment facilities impossible. Close contact between treatment plant operators and industrial plant production managers is necessary to prevent abuse of the combined system and to prevent upsets in treatment processes whenever possible. Notification of treatment plant personnel in case of inadvertent spills or discharges of concentrated process solutions will allow most efficient handling of such situations at the treatment facility. However, the reluctance of industry to properly educate production personnel regarding in-plant waste abatement practices and to emphasize the importance of cooperation with treatment facility personnel will significantly increase problems associated with the operation of combined treatment facilities.

Even with proper cooperation between industries and the treatment authority, operation of the treatment facilities may be complicated by changes in industrial manufacturing processes. Because of the dependence of industrial production on consumer demands, it is often difficult to predict products which will be produced in a particular plant and corresponding waste loads which will be produced more than a few years into the future. Thus, while a combined waste treatment facility may be designed to adequately treat wastes originating from several plants at a particular point in time, changes in the products produced by these plants, and changes in existing manufacturing processes may make the treatment facility inadequate for treating waste produced five to ten years in the future.

In summary, the principle factors which must be analyzed in planning combined industrial waste treatment facilities are 1) financing and operation of facilities, 2) industrial attitudes toward cooperating with treatment plant personnel to maintain conditions amenable to the proper operation of the facility, and 3) proper wastewater characteristics to make combined treatment feasible. The latter point may be of more importance than is at first appreciated. In many cases industrial waste discharges vary daily or seasonally depending on production. Thus, if neutralization is planned by combining two waste streams, adequate equalization facilities must be provided to absorb fluctuations in wastestreams.

In addition, it must be determined if adequate quantities of acid and alkaline wastes will be produced by the various industries involved. In some cases it would be necessary to purchase additional chemicals to obtain desired levels of treatment.

POTENTIAL COMBINED INDUSTRIAL WASTE TREATMENT FACILITIES

In this section several combined treatment projects which seem most feasible in the Three Rivers Watershed area will be discussed. Because these projects are examined more closely in the Phase II report, they are mentioned only briefly at this time.

Water Reuse in the Steel Industry

A plan for reuse of the Cleveland Southerly effluent in the steel mills located along the lower Cuyahoga River was investigated by Battelle Institute for the Ohio Water Development Authority in 1968 [4]. Treatment provided at the Southerly plant would consist of biological treatment followed by chlorination with an optional plan for additional suspended solids removal. All wastes were to be treated in a terminal treatment facility operated by OWDA which would provide removal of phosphorus, suspended solids, and oil.

While the Southerly effluent following chlorination and removal of suspended solids might not be suitable for all uses in the steel mills, approximately 50 percent of the flow should be useable for process water. Due to the revised water quality standards being implemented at the present time, the terminal treatment facility originally proposed would be inadequate.

Chemical precipitation, filtration, aeration, and activated carbon treatment would be required to meet anticipated federal water quality goals. Even with this treatment some wastes from the steel industry containing cyanides would have to receive additional treatment. However, investigations are currently under way to discharge some of these wastes to the municipal sewer system.

The principal reason for considering this plan again is the savings in treatment costs which would be realized. This savings would probably be greater than in the originally proposed plan because of the more stringent water quality standards involved. However, the final economics of this plan would depend on the degree of water reuse practiced by the steel industry.

Oil Collection and Disposal

A second project considered by Battelle [4] was the collection of oil wastes and disposal at a central location. It was suggested that waste treatment facilities of an abandoned oil refinery be rehabilitated for this purpose.

In 1968, the Standard Oil Company moved its refinery operations away from Cleveland and gave the Kingsbury Run plant to the City of Cleveland. Facilities at the refinery included a wastewater treatment plant designed for a flow of 14.4 mgd. The cost for rehabilitation of this plant for use as an oil disposal facility has been estimated to be $650,000 [3]. Materials which would possibly be included in this

programs are oils, greases, tar, asphalt, paint residues, and solvents. This plan is also recommended for implementation in the Northeast Ohio Water Development Plan [3].

Utilization of Spent Pickle Liquor

Two major water quality problems of the Cuyahoga Basin and Lake Erie are excessive nutrients and spent pickle liquors from steel production. With the implementation of agreements made in the International Joint Council, phosphorus removal will be required extensively in the Three Rivers Watershed area. At the present time most spent pickle liquor from steel mills is hauled away for disposal.

As a means of disposing of spent pickle liquors and accomplishing phosphorus removal, Mr. George B. Garrett of the Ohio EPA has proposed that the pickle liquor be used in municipal treatment plants for phosphorus removal. This has been experimented with in other locations and appears feasible when adequate process controls are included in the design.

Preliminary investigations by Garrett [12] showed that approximately 5,000,000 pounds of $FeCl_2$ per month is currently produced in the Cleveland-Youngstown area. While this amount might be inadequate for the entire Study Area, supplementary ferric chloride could be substituted at smaller plants in the area as required.

The facilities required for this project would include storage and distribution facilities and a means of transporting the spent liquors. Private trucking firms which presently remove the spent liquor from steel mills in the area could provide the required transportation.

ATTACHMENTS

ATTACHMENT A

State of Ohio Water Quality Standards

Attachment A contains the State of Ohio water quality standards adopted by the Water Pollution Control Board on April 14, 1970. Although effluent standards have been proposed to accomplish these criteria, this resolution was the official standard during 1972.

WATER POLLUTION CONTROL BOARD

OHIO DEPARTMENT OF HEALTH

COLUMBUS, OHIO

RESOLUTION ESTABLISHING AMENDED CRITERIA OR STREAM-WATER QUALITY

FOR VARIOUS USES ADOPTED BY THE BOARD ON APRIL 14, 1970

WHEREAS, Section 6111.03, of the Ohio Revised Code, provides, in part, as follows:

"The water pollution control board shall have power:

(A) To develop programs for the prevention, control and abatement of new or existing pollution of the waters of the state; ..." and

WHEREAS, Primary indicators of stream-water quality are needed as guides for appraising the suitablity of surface waters in Ohio for various uses; and

WHEREAS, The stream-water quality criteria for various uses and minimum conditions applicable to all waters adopted by the Board of June 14, 1966, have been amended by the Ohio River Valley Water Sanitation Commission; and

WHEREAS, The criteria adopted by the Board on October 10, 1967, have been further amended by the Ohio River Valley Water Sanitation Commission;

THEREFORE BE IT RESOLVED, That the following amended stream-water quality criteria for various uses, and minimum conditions

applicable to all waters, and policies for protection of high quality waters and for water quality design flow, are hereby adopted in accordance with amendments of the Ohio River Valley Water Sanitation Commission, and the recommendations of the Federal Water Pollution Control Administration.

AND BE IT FURTHER RESOLVED, That the amended stream-water quality criteria for various uses, for minimum conditions, for protection of high quality waters, and, for water quality design flow, be made applicable to the following waters of the state:

1. Maumee, Tiffin, St. Joseph, and St. Mary's River Basins;
2. Lake Erie & Interstate Waters thereof;
3. Great Miami, Whitewater, and Wabash River Basins;
4. Ashtabula River, Conneaut and Turkey Creeks;
5. Ohio River of Ohio-West Virginia and Ohio-Kentucky;
6. North Central Ohio Tributaries of Lake Erie;
7. Scioto River Basin;
8. Little Miami River Basin;
9. Rocky, Cuyahoga, Chagrin, and Grand River Basins;
10. Muskingum River Basin;
11. Hocking River Basin.

MINIMUM CONDITIONS APPLICABLE TO ALL WATERS AT ALL PLACES AND AT ALL TIMES

1. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable sludge deposits.
2. Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious.
3. Free from materials attributable to municipal, industrial or other discharges, or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance.
4. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

PROTECTION OF HIGH QUALITY WATERS

Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at their existing high quality, pursuant to the Ohio water pollution control statues, or presently possible, in such waters. This will require that any industrial, public or private project or development which would constituent a new source of pollution or an increased source of pollution

to high quality waters will be required, as part of the initial project design, to provide the most effective waste treatment available under existing technology. The Ohio Water Pollution Control Board will cooperate with other agencies of the state, agencies of other states, interstate agencies and the Federal Government in the enforcement of this policy.

WATER QUALITY DESIGN FLOW

Where applicable for the determination of treatment requirements the water quality design flow shall be the minimum seven consecutive day average that is exceeded in 90 percent of the years.

STREAM-QUALITY CRITERIA

FOR PUBLIC WATER SUPPLY

The following criteria are for evaluation of stream quality at the point at which water is withdrawn for treatment and distribution as a potable supply:

1. Bacteria: Coliform group not to exceed 5,000 per 100 ml as a monthly average value (either MPN of MF count); nor exceed this number in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five percent of such samples.
2. Threshold-odor Number: Not to exceed 24 (at 60°C) as a daily average.
3. Dissolved Solids: Not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time.

4. Radioactivity: Gross beta activity not to exceed 1,000 picocuries per liter (pCi/l), nor shall activity from dissolved strontium-90 exceed 10 pCi/l, nor shall activity from dissolved alpha emitters exceed 3 pCi/l.

5. Chemical constituents: Not to exceed the following specified concentrations at any time.

Constituent	Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.01
Silver	0.05

FOR INDUSTRIAL WATER SUPPLY

The following criteria are applicable to stream water at the point at which the water is withdrawn for use (either with or without treatment) for industrial cooling and processing:

1. Dissolved oxygen: Not less than 2.0 mg/l as a daily-average value, nor less than 1.0 mg/l at any time.

2. pH: Not less than 5.0 nor greater than 9.0 at any time.

3. Temperature: Not to exceed 95 deg. F. at any time.

4. Dissolved solids: Not to exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time.

FOR AQUATIC LIFE A

The following criteria are for evaluation of conditions for the maintenance of a well-balanced, warm-water fish population. They are applicable at any point in the stream except for areas necessary for the admixture of waste effluents with stream water.

1. Dissolved oxygen: Not less than an average of 5.0 mg/l per calendar day and not less than 4.0 mg/l at any time.

2. pH:

   A. No values below 6.0 nor above 8.5 .

   B. Daily fluctuations which exceed the range of pH 6.0 to pH 8.5 and are correlated with photosynthetic activity may be tolerated.

3. Temperature:

   A. No abnormal temperature changes that may affect aquatic life unless caused by natural conditions.

   B. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

   C. Maximum temperature rise at any time or place above natural temperatures shall not exceed 5 deg. F. In addition, the water temperature shall not exceed the maximum limits indicated in the following table.

Waters	Maximum Temperature in Deg. F. During March Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
All waters except Ohio River	50	50	60	70	80	90	90	90	90	78	70	57
Main Stem-Ohio River	50	50	60	70	80	87	89	89	87	78	70	57

4. Toxic Substances: Not to exceed one-tenth of the 48-hour median tolerance limit, except that other limiting concentrations may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agency.

FOR AQUATIC LIFE B

The following criteria are for evaluation of conditions for the maintenance of desirable biological growths and, in limited stretches of a stream, for permitting the passage of fish through the water, except for areas necessary for admixture of effluents with stream water:

1. Dissolved oxygen: Not less than 3.0 mg/l as a daily-average value, nor less than 2.0 mg/l at any time.
2. pH: Not less than 6.0 nor greater than 8.5 at any time.
3. Temperature: Not to exceed 95 deg. F. at any time.
4. Toxic substances: Not to exceed one-tenth of the 48-hour median

tolerance limit, except that other limiting concentrations may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agency.

FOR RECREATION

The following criterion is for evaluation of conditions at any point in waters designated to be used for recreational purposes, including such water-contact activities as swimming and water skiing:

Bacteria: The fecal coliform content (either MPN or MF count) not to exceed 200 per 100 ML as a monthly geometric mean based on not less than five samples per month; nor exceed 400 per 100 ML in more than ten percent of all samples taken during a month.

FOR AGRICULTURAL USE AND STOCK WATERING

The following criteria are applicable for the evaluation of stream quality at places where water is withdrawn for agricultural use or stock-watering purposes:

1. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable sludge deposits.
2. Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious.

3. Free from materials attributable to municipal, industrial or other discharges, or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance.
4. Free from substances attributable to municipal, industrial or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

WATER POLLUTION CONTROL BOARD

DEPARTMENT OF HEALTH

COLUMBUS, OHIO

WATER QUALITY CRITERIA ADOPTED BY THE BOARD APRIL 11, 1967

FOR LAKE ERIE AND THE INTERSTATE WATERS THEREOF

The Ohio Water Pollution Control Board hereby adopts the following water quality criteria for Lake Erie and the interstate waters thereof which may affect the State of Michigan, the Commonwealth of Pennsylvania, the State of New York, and the Providence of Ontario of the Dominion of Canada.

Water Quality - Conditions and Criteria

All Waters. All the waters considered herein shall meet the following conditions at all times:

(1) They shall be free from substances attributable to municipal, industrial, or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits.

(2) They shall be free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, or other discharges in amounts sufficient to be unsightly or deleterious;

(3) They shall be free from materials attributable to municipal, industrial, or other discharges producing color, odor, or

other conditions in such degree as to create a nuisance; and,

(4) They shall be free from substances attributable to municipal, industrial, or other discharges in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.

Lake Erie Water Quality Criteria for Various Uses are: (1) the Stream-Water Quality Criteria for Various Uses adopted by the Ohio Water Pollution Control Board of June 14, 1966, copy attached, which shall apply as a minimum to all Lake Erie waters in Ohio, and (2) the existing lake water quality which shall apply where better than the criteria for streams adopted by the Board. The existing lake water quality shall be as reported by the Federal Water Pollution Control Administration in the chapter on Water Quality in report "Program for Water Pollution Control - Lake Erie - 1967".

Lake Erie outside the established harbors at Lorain, Cleveland, and Astabula shall meet the Lake Erie water quality criteria for all uses.

The Lorain, Cleveland, and Ashtabula harbor waters in Lake Erie shall meet the Lake Erie water quality criteria for industrial water supply and aquatic life (A).

ATTACHMENT B

INDUSTRIES HOLDING STATE

OF OHIO DISCHARGE PERMITS

This section contains information for industires which held discharge permits from the State of Ohio in 1968. Information was obtained from a report prepared by the Ohio Department of Health [10].

TABLE B-I

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
ROCKY RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
The Farm Packt Pickle Co.	Medina Co. Montville TWP.	West Branch Rocky R.	Food Proc. (Cannery)	Oxygen Demand Chlorides Suspended Solids	None
General Motors Corp. Allison Division Tank Plant	Brook Park	Abram Creek	Metal Finish.	Acids, Chrome, Cyanides.	Chrome reduction Cyanide oxidation Acid neutralization PPT[a] of Metals
Modern Tool and Die Co.	Medina Co. Liverpool TWP.	West Branch Rocky R.	Steel--Misc.	Oils	Oil separation
National Aeronautical and Space Administration[b]	Brook Park	Rocky River	Research lab.	Acids, Oils, Fuels, Chromium	In-plant controls Oil separators, Settling

[a] PPT - Precipitation

[b] Not under permit to the Ohio Water Pollution Control Board

SOURCE: Reference [10].

TABLE B-II

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
Air Reduction Co., Inc. Airco Welding Prod.Div. Arcrode Plant	Cuyahoga Heights	Cuyahoga R.	Chemical	Metals Suspended Solids	Settling
Alside Homes Corp.	Simmit Co. Northampton TWP.	Mid Brook	Mfg. of Aluminum Prod. (Sewage)	Sanitary Sewage	Secondary Treatment
Astoria Plating Corp.	Parma	Trib. of Big Creek	Metal Finish.	Acids, Cd, Cu, Cr, Nl, Zn, & Cn	Temp. facilities for cyanide oxidation, chrome reduction, acid neutralization, PPT of metals
The Bailey Wall Paper Co.	Cleveland	Big Creek	Wall Paper Mfg.	Oxygen Demand Suspended Solids	None
Bedford Gear Co.	Walton Hills	Trib. of Tinkers Crk.	Gear Mfg.	Oil	Minor
Burdett Oxygen Co. of Cleveland, Inc.	Cleveland	Cuyahoga R.	Chemical	Suspended and Dissolved Solids	Lagoons
Busson Brothers Sand & Gravel Co.	Summit Co. Bath TWP.	Yellow Creek	Sand & Gravel	Suspended and Dissolved Solids	Lagoons
Consolidated Freightways	Summit Co. W. Richfield TWP.	Trib. of Cuyahoga R.	Truck Wash	Acids, Organics, Oil, Suspended Solids	Neutralization, Lagoons, Oil Removal

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
Cormax Metal Treating Co., Inc.	Geuga Co. Troy TWP.	Trib. of Cuyahoga R.	Heat Treat.	Cyanides, Oils	Cyanide Oxidation Lagoon
The Cornwell Quality Tools Co.	Mogadore	Outlet of Winfoot Lake L. Cuyahoga R.	Metal Finish.	Acids, Chrome	Controlled Discharge
The Cuyahoga Meat Co.	Cleveland	Big Creek	Meat Packing	Oxygen Demand Suspended Solids	Septic Tank and Filter
Diamond Crystal Salt Co.	Akron	Ohio Canal Summit Lake	Chemical	Chlorides	Discharge to Municipal Sewers, Elimination of Chloride Discharges underway.
E.I. Dupont de Nemours & Co., Inc. Industrial & Biochemicals Dept.	Cleveland	Cuyahoga R.	Chemical	Acids, Zinc, Ammonia	In-Plant Controls, Acid Neutralization, PPT of Zinc.
The Elco Corp.	Cleveland	Cuyahoga R.	Lubricants	Oil	Separator
Ferro Chemical Div. Ferro Corp.	Walton Hills	Ditch Trib. to Tinkers Cr.	Chemical	Suspended Solids	Incineration
The Firestone Tire & Rubber Co.	Akron	Ohio Canal	Rubber	Oxygen Demand, Organics, Oils, Suspended Solids	Pretreatment and Discharge to Municipal Sewers

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
The Flintkote Co. Pipe Prods. Group	Portage Co. Rootstown TWP.	Breakneck Cr.	Asbestos-Cement Pipe Plant	Acids Suspended Solids	Chemical Treat. Lagoons
Ford Motor Co. Engine Plts. 1&2	Brook Park	Trib. of Big Creek	Engine Plt.	Oils	Chemical Treat. Oil Separation
The B.F. Goodrich Co.	Akron	Ohio Canal	Rubber	Oxygen Demand, Oils, Organics, Suspended Solids	Pretreatment and Discharges to Municipal Sewers
Goodrich-Gulf Chemicals, Inc.	Independence	Cuyahoga R.	Chemical	Organics Suspended Solids	Separators Lagoons
Goodyear Aerospace Corp.	Akron	Trib. to Lt. Cuyahoga R.	Metal Finish.	Acids, Chrome, Copper, Cyanides, Suspended Solids	Settling, Some Wastes Now Trib to Akron Sewers
The Goodyear Tire & Rubber Co.	Akron	Lt. Cuyahoga River	Rubber	Oils, Suspended Solids, Oxygen Demand, Organics	Reductions of Oils and Suspended Solids
The Harshaw Chemical Co. Div. of Kewanee Oil Co.	Cleveland	Cuyahoga R.	Chemical	Metal Salts	In-Plant Controls, Recovery of Metals
Hilltop Sand & Gravel Co.	Portage Co. Brimfield TWP.	Trib. to Lt. Cuyahoga R.	Sand & Gravel Washing	Suspended Solids	Lagoons

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
Allied Chemical Corp. Industrial Chem. Div. National Works	Garfield Hgts.	Mill Creek	Chemical	Acids Dissolved Solids	Acid Neutralization In-Plant Controls
Jones & Laughlin Steel Corp.	Cleveland	Cuyahoga R.	Steel (Acid Iron)	Acid, Iron	Controlled Discharge of Rinse Waters
Jones & Laughlin Steel Corp.	Cleveland	Cuyahoga R.	Steel (Blast Fur.)	Suspended Solids Iron	Clarification
Jones & Laughlin Steel Corp.					
New Rolling Mill	Cleveland	Cuyahoga R.	Steel (Mill Scale)	Suspended Solids Oil, Iron	Clarification Oil Removal, Reuse of Treates Wastes
Old Rolling Mill	Cleveland	Cuyahoga R.	Steel (Mill Scale)	Suspended Solids, Iron, Oil	Clarification Oil Removal
The Lamson & Sessions Co.	Kent	Cuyahoga R.	Metal Finish.	Acids, Oil	Chemical Treat. Oil Separation
Lerkis Asphalt Co., Inc.	Akron	Lt. Cuyahoga River	Acid Sand Washing	Acids, Iron Suspended Solids	Lagoons

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
Cormax Metal Treating Co., Inc.	Geauga Co. Troy TWP.	Trib. of Cuyahoga R.	Heat Treat.	Cyanides, Oils	Cyanide Oxidation Lagoon
The Cornwell Quality Tools Co.	Mogadore	Outlet of Winfoot Lake L. Cuyahoga R.	Metal Finish.	Acids, Chrome	Controlled Discharge
The Cuyahoga Meat Co.	Cleveland	Big Creek	Meat Packing	Oxygen Demand Suspended Solids	Septic Tank and Filter
E.I. Dupont de Nemours & Co., Inc. Industrial & Biochemicals Dept.	Cleveland	Cuyahoga R.	Chemical	Acids, Zinc, Ammonia	In-plant controls, Acid Neutralization, PPT of Zinc
The Elco Corp.	Cleveland	Cuyahoga R.	Lubricants	Oil	Separator
Ferro Chemical Div. Ferro Corp.	Walton Hills	Ditch Trib. to Tinkers Cr.	Chemical	Suspended Solids	Incineration
The Firestone Tire & Rubber Co.	Akron	Ohio Canal	Rubber	Oxygen Demand, Organics, Oils, Suspended Solids	

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
M & M Sand & Gravel Co., Inc.	Akron	Camp Brook Lt. Cuyahoga River	Sand & Gravel Washing	Suspended Solids	Lagoon
Master Ahodizers & Platers, Inc.	Walton Hills	Trib. of Tinkers Crk.	Metal Finish.	Chrome, Acids, Aluminum, Suspended Solids	Chrome Reduction, Acid Neutralization, PPT of Metals
Middlefield Swiss Cheese Co-Op Association	Geauga Co. Middlefield TWP.	Underground Trib. of Cuyahoga R.	Milk Proc.	Oxygen Demand, Suspended Solids	Land Spray Disposal
Modern Tool & Die Co.	Parma	Big Creek	Steel--Misc.	Oils, Fats	None
Norce, Inc.	Bedford Hgts.	Trib. of Tinkers Crk.	Steel--(Misc.)	Oils	Oil Separation
Ohio Edison Co. Gorge Plant	Akron	Cuyahoga R.	Heat & Power	Suspended Solids Heated Water	Fly Ash Lagoons
Republic Steel Corp.					
Bolt & Nut Div.	Cleveland	Cuyahoga R.	Steel (Acid Iron)	Acids, Iron Metals Cyanides	Controlled Discharge
Bolt & Nut Div.	Cleveland	Cuyahoga R.	Steel (Mill Scale)	Suspended Solids Oil	Scale Pits
Cleveland Dist.	Cleveland	Cuyahoga R.	Steel (Acid Iron)	Acids, Iron	Controlled Discharge

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
Cleveland Dist.	Cleveland	Cuyahoga R.	Steel (Blast Fur.)	Suspended Solids	Clarification
Cleveland Dist.	Cleveland	Morgana Run Burke Run	By-Prod. Coke (Phenol)	Phenols, Ammonia	Depheolizer, Closed Quenching
Cleveland Dist.	Cleveland	Cuyahoga R.	Steel (Mill Scale	Suspended Solids	Scale Pits & Oil Removal, Dry Scale Removal
Research Center	Independence	Unnamed Creek	Research Center	Chemicals	Chemical Treatment Clarification
Smallwood Packing Co., Inc.	Geauga Co. Middlefield TWP.	Underground Drainage Basin of Cuyahoga R.	Meat Packing	Oxygen Demand Suspended Solids	Aerated Lagoon Clarification
Sonoco Products Co. Ohio Div.	Munroe Falls	Cuyahoga R.	Paper Mill	Oxygen Demand Suspended Solids	Aerated Lagoon Clarification
The Standard Oil Co. #2 Refinery	Cleveland	Kingsbury Run	Oil Refinery	Oil	Oil Separation
Tecumseh Corrugated Box Co., Jaite Mill Div.	Summit Co. Northfield TWP.	Cuyahoga R.	Paper Mill	Oxygen Demand Suspended Solids	Aerated Lagoon

TABLE B-II (Cont.)

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CUYAHOGA RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
United States Steel Corp.					
Central Furnaces	Cleveland	Cuyahoga R.	Steel (Blast Fur.)	Suspended Solids Iron	Clarification
Cuyahoga Works	Cuyahoga Hgts.	Cuyahoga R.	Steel (Acid Iron)	Acids, Iron	Controlled Discharge
Cuyahoga Works	Cuyahoga Hgts.	Cuyahoga R.	Steel (Mill Scale)	Suspended Solids	Scale Pits, Lagoon
The Walker China Co.	Bedford Hgts.	Tinkers Crk.	Ceramics	Suspended Solids	Lagoon
Weather-Tite Div. Pacific Coast Co.	Walton Hills	Trib. of Tinkers Crk.	Metal Finish.	Acids, Aluminum, Suspended Solids	Neutralization, Settling
S. K. Wellman Div. Abex Corp.	Bedford	Tinkers Crk.	Metal Finish.	Acids, Nickle, Copper, Cyanide	Cyanide Oxidation Acid Neutralization PPT of Metals
Zirconium Corp. of America	Solon	Trib. of Tinkers Crk.	Chemical	Metals, Acids	Acid Neutralization PPT of Metals

TABLE B-III

INDUSTRIAL WATER POLLUTION CONTROL FACILITIES--
CHAGRIN RIVER DRAINAGE BASIN

Plant Name	Location	Receiving Stream	Type of Industry	Critical Constituents	Treatment Provided
Chase Bag Co.	Chagrin Falls	Chagrin R.	Paper Mill	Oxygen Demand Suspended Solids	(1) Filtration (2) Pretreatment with Connection to Municipal Sewers
Custom Beverage Packers, Inc.	Aurora	Sunny Lake Aurora Br. Chagrin R.	Food Proc. (Misc.)	Oxygen Demand	Aerated Lagoon
General Biochemicals Div. of N. American Mogul Prod. Co.	Geauga Co. Bainbridge TWP.	Ditch Trib. of Chagrin R.	Chemical	Acids Suspended Solids	Acid Neutralization Settling, Controlled Discharge
Moss Farm Dairy, Inc.	Geauga Co. Chester TWP.	Griswold Crk.	Milk Proc.	Oxygen Demand Suspended Solids	Sand Filters
Mulberry Sand & Gravel Co.	Geauga Co. Chester TWP.	E. Branch of Chagrin R.	Sand & Gravel	Suspended Solids	Settling
Pennsylvania Glass Sand Corp. Industrial Silica Div. Geauga Plant	Portage Co. Aurora TWP.	Small Trib. of Chagrin R.	Sand & Gravel	Suspended Solids	Settling

ATTACHMENT C

INDUSTRIES APPLYING FOR

CORPS OF ENGINEERS

DISCHARGE PERMITS

Attachment C contains data obtained from discharge permit applications for the Three Rivers Watershed. Information summarized includes plant name and SIC classification, location, products, employment, and water usage and wastewater discharge data.

TABLE C-I

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS -CUYAHOGA RIVER BASIN[a]

SIC No.	Name	Location	Products	Employment	Water Usage Process (MGD)	Water Usage Cooling (MGD)	Wastewater Discharge Point of Discharge	Flow to River (MGD)	Flow to Sewer (MGD)	Type of Waste to River
2011	Cuyahoga Meat Co.	Cleveland	Packaged Meat	30	0.004	0.005	Big Creek	0.009	0.001	Process, Cooling
2093	Sherwin Williams	Cleveland	Linseed Oil	105	0.009	0.43	Cuyahoga	0.41	0.03	Process, Cooling
2881	Ferro Chemical	Walton Hills	Metalorganic Soaps	94	-	0.32	Tinkers Creek	0.312	-	Cooling, Boiler
281	Zirconium Corp. of America	Solon	Zirconium Oxide	80	0.08	0.02	Tinkers Creek	0.113	0.01	Cooling, Process
2813	Burdett Oxygen Co.	Cleveland	Acetylene	7	0.005	0.003	Cuyahoga	-	-	Process, Cooling
2819	Allied Chemical Corp.	Garfield Heights	H_2SO_4 & $Al_2(SO_4)_3$	78	0.10	0.14	Mill Creek	0.27	0.01	Process, Cooling
2819[b]	Harshaw Chemical Corp.	Cleveland	Chemical Catalysts	400	0.25	0.73	Big Creek	1.5	0.01	Process, Cooling
2821[c]	Goodyear Aero-space Corp.	Akron	Vinyl Film Wheels	2000	1.15	0.8	Haley's Ditch	0.8	1.2	Cooling, Boiler
2822	Independence Development Center	Indepen-dence	Synthetic Rubber	110	0.03	0.025	Unnamed Creek	0.03	0.005	Process
2851	Sherwin Williams Co.	Cleveland	Paint	-	-	0.24	Cuyahoga	0.22	0.21	Cooling
2899	International Salt Co.	Cleveland	NaCl	268	0.72	0.40	Old River	0.938	-	Process, Cooling
29	Parr, Inc.	Cleveland	Oils, Grease Roof Coatings	74	-	0.002	Creek	0.0014	0.002	Boiler, Cooling

TABLE C-I (cont'd)

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

SIC No.	Name	Location	Products	Employment	Water Usage: Process (MGD)	Water Usage: Cooling (MGD)	Point of Discharge	Wastewater Discharge: Flow to River (MGD)	Wastewater Discharge: Flow to Sewer (MGD)	Type of Waste to River
2992	Elco Corp.	Cleveland	Lubricants Oil	33	0.001	0.043	Cuyahoga	0.0216	0.018	Cooling
2992	Standard Oil Co.	Cleveland	Lubricants Oil	113	0.17	-	Cuyahoga	0.331	0.04	Boiler, Storm runoff
3011	General Tire & Rubber	Akron	Tires, Rubber	3460	0.01	4.91	Little Cuyahoga	4.56	0.19	Cooling
3011[d]	Goodyear Tire & Rubber	Akron	Synthetic Tires, Rubber	13000	2.10	34.2	Little Cuyahoga	34.2	2.2	Boiler, Cooling
3020	Hamilton Kent Mfg. Co.	Portage County	Extruded Rubber	50	-	0.002	Breakneck Creek	0.0216	-	Cooling
3069	Johnson Rubber Co.	Middle-field	Mech. Rubber Products	700	-	0.165	Cuyahoga	0.165	0.015	Boiler, Cooling
3069	Norton Co.	Ravenna	Rubber Molded Goods	102	-	0.09	Wahoo Creek	0.086	0.002	Cooling
3069	RCA Rubber Co.	Akron	Rubber Flooring	205	-	1.179	Little Cuyahoga	1.0	0.14	Boiler, Cooling
3079	Amoco Chemical Corp.	Stow	Plastic Pipe & Fittings	200	-	0.14	Storm Ditch	0.14	0.01	Cooling
3079	Continental Oil Co.	Aurora	Plastic Pipe & Conduit	-	-	0.72	Unnamed River	0.0005	-	
30	Ohio Rubber Co.	Willoughby	Rubber Products	-	0.70	0.27	-	0.1	0.8	-

TABLE C-I (cont'd)

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

					Water Usage		Wastewater Discharge			
SIC NO	Name	Location	Products	Employment	Process (MGD)	Cooling (MGD)	Point of Discharge	Flow to River (MGD)	Flow to Sewer (MGD)	Type of Waste to River
3079	Ferriot Bros. Inc.	Crawford Twp	Plastic Parts	-	-	0.0028	Little Cuyahoga	0.0028	-	Cooling
3079	Johnson Plastic Corp.	Auburn Township	Plastic Products	180	0.0008	0.0012	Bridge Creek	0.0015	-	Cooling, Process
3079	Norton Company	Ravenna	Fiberglass Vinyl	65	0.009	0.007	Ravennah Storm Sewer	0.017	0.002	Cooling, Other
3079	Norton Company	Springfield Twp.	PCV Tubing	130	-	0.40	Little Cuyahoga	0.40	0.004	Cooling
3079	Vlchek Plastics Co.	Middle-field	Fishing tackle boxes	120	-	0.044	Open Ditch East Branch	0.044	0.001	Cooling
32	Norton Company	Ravenna	Ceramic catylist Carriers	33	0.017	0.002	-	0.012	0.008	
32	Norton Company	Tallmadge	Ceramic Tower Packing	120	0.0033	0.0002	-	-	0.0008	
3262	Walker China Co.	Bedford	Chinaware	150	0.002	-	Tinkers Creek	0.002	-	Process
3281	M & M Sand & Gravel Co.	Akron	Washed Sand & Gravel	-	0.072	-	Camp Brook Creek	0.03	-	Process
3292[e]	The Flintkote Co.	Rootstown Twp.	Asbestos, Cement Pipe	213	1.23	0.24	Breakneck Creek	1.8	0.01	Process, Cooling

TABLE C-I

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

SIC NO	Name	Location	Products	Employment	Water Usage: Process (MGD)	Water Usage: Cooling (MGD)	Point of Discharge	Wastewater Discharge: Flow to River (MGD)	Wastewater Discharge: Flow to Sewer (MGD)	Type of Waste to River
3295	Hydraulic Press Bric Co.	Independence	Expanded Shale Aggragate	-	0.56	0.04	Hemlock Creek	0.32	-	Process, Other
3312	Jones & Laughlin Steel Corp	Cleveland	Cold Roll Steel	4120/ 4450	0.65	67.33	Cuyahoga	3.12	1.09	Process
332	Cormax Metal Treating	Troy Twp.	Soap NaCN	5	0.0001[f]	0.0001	Nava Road Ditch	0.0002	-	Rinsing, Cooling
3321	The A. C. Williams Co.	Ravenna	Gray Iron Castings	235	0.003	0.007	Penn Central RR Ditch	0.004	0.04	Cooling
334	Bradley Metal Co.	Cleveland	Refined Aluminum	45	0.08	-	Cuyahoga	0.08	-	Process
334	The River Smelting & Refining Co.	Cleveland	Refined Non-ferrous	40	0.02	0.04	Cuyahoga	0.06	-	Process, Cooling
3341	Cuyahoga Smelting Co.	Cleveland	Reclaimed Aluminum	12	-	0.03	Cuyahoga	0.033	-	Cooling
336	Lester Industries Inc.	Bedford Hts.	Aluminum Die Castings	250	0.006	0.0101	Storm Sewer to Bear Creek	0.0024	0.004	Cooling, Process
3361[g]	The A.C.Williams Co.	Ravenna	Al & Mg Ingots	115	0.015	0.007	Erie Lacka-wanna	0.022	0.028	Process, Cooling
34	Interspace Corp.	Solon	Steel	50	0.03	0.05	Tinkers Creek	0.045	0.04	Boiler, Cooling
34	North American Rockwell Corp	Bedford Hts.	Filters & Valves	450	0.041	0.0021	Tinkers Creek	0.09	0.051	0.1 in.

TABLE C-I (cont'd)

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS

FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

					Water Usage		Wastewater Discharge			
SIC NO	Name	Location	Products	Employment	Process (MGD)	Cooling (MGD)	Point of Discharge	Flow to River (MGD)	Flow to Sewer (MGD)	Type of Waste to River
3452	The Lamson & Sessions Co.	Kent	Nuts	390	1.54	0.04	Cuyahoga	0.0015	1.58	Cooling
3452	Republic Steel Corp.	Cleveland	Industrial Fastners	1000	2.58	2.44	Cuyahoga	2.23	1.0	Cooling, Process
3461[h]	Chevrolet Mtr. Division	Parma	Sheet Steel Shaft Forg.	8450	0.45	0.23	Sewer, County Storm	0.216	1.18	Boiler, Cooling
3461	Ford Mtr. Co.	Walton Hills		4319		0.08	Cuyahoga		0.22	Cooling, Boiler
3471	Master Anodizers & Platers	Walton Hills	Anodized Aluminum	33	0.07	-	Tinkers Creek	0.069		Process
3471	Pacific Coast Co.	Walton Hills	Aluminum	600	0.49	-	Tinkers Creek	0.432	0.07	Process
3479	Associate Japanning Co.	Brooklyn Heights	App of Paint to metal	35	0.016	-	Cuyahoga	0.018	-	Process, Sanitary
3481	The U.S. Steel Wire Spring Co.	Cleveland	Spring Wire, Forms		0.008	0.01	Unknown	0.018	0.012	Cooling, Process
3494	Eaton Corp Fluid Power Div.	Brooklyn	Hydraulic Cont. Comp.	70	-	0.001	Big Creek	0.002	0.001	
3499	Eaton Corp Engr. Fastners Div.	Brooklyn	Fastners	850	0.067	0.02	Big Creek Parkway Ditch	0.078	0.078	
35	Akron Standard Div of Eage Picher Inc.	Greenwich	Rubber Mach Tire Molding	180		0.006	Traverse Creek	0.0058	0.01	Cooling

TABLE C-I (cont'd)

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

					Water Usage			Wastewater Discharge		
SIC NO	Name	Location	Products	Employment	Process (MGD)	Cooling (MGD)	Point of Discharge	Flow to River (MGD)	Flow to Sewer (MGD)	Type of Waste to River
35	Eaton Corp. Industrial Drivers Div	Brooklyn	Industrial Clutches & Brakes	-	-	0.007	Big Creek	- 0.015	- -	Cooling
3522[i]	SK Wellman Corp	Bedford	Bi Metallic Friction Mat.	550	-	0.383	Tinkers Creek	0.235	0.05	Boiler
3531	Terex Div of GMC Hudson	Hudson Twp.	Earth moving Equipment	-	-		Steam to Mud Brook	0.0015	0.2	Storm Runoff
3548	Black & Decker Mgf. Co.	Solon	Pneumatic Tools	-	0.003	0.007	Drainage Ditch	0.10	-	Cooling, Process
3623	Arico Welding Products	Cuyahoga Heights	Welding Electrodes	145	-	0.14	Cuyahoga	0.002	0.15	
3714[j]	Ford Mtr. Co.	Cleveland Brook Park	Auto & Truck Engines	9500	1.03	2.18	West Branch Big Creek	1.77	1.35	Process, Cooling
3729	Goodyear Aero-space Corp.		Airship Components	101	0.006	0.001[k]	Wingfoot Lake	0.006	-	Process
4011	Baltimore & Ohio RR	Cleveland	Railway Yard	-	-	0.004	Cuyahoga	0.009	-	Cooling
4011	Baltimore & Ohio RR	Akron	Railway Yard	-	-		Little Cuyahoga	0.008	-	
4011	Norfolk & Western RR	Cleveland	Railway Yard	33	-	0.004	Kingsbury Sewer	0.005	-	Storm Runoff, Cooling

TABLE C-I (cont'd)

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

SIC NO	Name	Location	Products	Employment	Water Usage: Process (MGD)	Water Usage: Cooling (MGD)	Wastewater Discharge: Point of Discharge	Wastewater Discharge: Flow to River (MGD)	Wastewater Discharge: Flow to Sewer (MGD)	Wastewater Discharge: Type of Waste to River
4463	Sun Oil Co.	Akron	Storage Terminal	35	-	-	Storm Sewer	0.001	-	Storm Runoff
4463	Ashland Oil	Cleveland		-	-	-	Cuyahoga	Highly Variable		Lake Water Ships Ballast
4613	Standard Oil Co (Ohio)	Cleveland		-	-	-	Cuyahoga	0.02	-	Storm Runoff
4613	Standard Oil Co.			-	-	-	Ditch to Little Cuyahoga	0.04	-	Storm Runoff
4613	Standard Oil Co.	Cleveland	Pump Station	-	-	-	Cuyahoga	0.02	-	Storm Runoff
491	Ohio Edison Co.	Akron	Electric Power	72	-	128.81	Cuyahoga	128.81	-	Cooling
493	Ametek Lamb Elec.	Kent	Elec Mtrs.	496	-	0.029	Cuyahoga	0.05	0.021	Cooling, Boiler
493	Darling Co.	Cleveland	Animal by-Products	40	0.01	1.43	Cuyahoga	1.4	0.04	Cooling
493[l]	EI duPont DeNemours	Cleveland	Organic Polymers	700	0.19	6.29	Cuyahoga	5.11	0.2	Cooling, Process
493[m]	Norton Co.	Tallmadge	Process Equip.	30	-	0.001	LittleCuyahoga	0.001	0.001	Cooling
493	Pesco Co.	Valley View	Aerospace Hardware	485	0.12	1.45[n]	Tinkers Creek	0.095	0.08	Process, Boiler
4961	Cleveland Elec. Illuminating Co.	Cleveland	Steam	50	0.34	0.84	Cuyahoga	0.371		Process, Cooling

TABLE C-I (cont'd)

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS

FOR DISCHARGE PERMITS - CUYAHOGA RIVER BASIN[a]

SIC NO	Name	Location	Products	Employment	Water Usage: Process (MGD)	Water Usage: Cooling (MGD)	Wastewater Discharge: Point of Discharge	Wastewater Discharge: Flow to River (MGD)	Wastewater Discharge: Flow to Sewer (MGD)	Type of Waste to River
4961	Ohio Edison Co.	Akron	Steam	29	-	0.37	Ohio Canal	0.0745	0.05	Boiler
5092	Gulf Oil Corp.	Cleveland	Petroleum Products	-	-	-	Cuyahoga	0.0003	-	Storm Runoff
5092	Shell Oil Co.	Cleveland	Lubricants Gasoline	75	-	0.0005	Cuyahoga	0.0028	0.003	
5092	Standard Oil Co.	Cleveland	Brine to Displace LPG	-	-		Cuyahoga	0.02	-	
5092	Standard Oil Co.	Cleveland	Gasoline	180	-		Cuyahoga	0.0001	0.0039	Storm Runoff
5092	Standard Oil Co.	Middlefield	Gasoline	2	-		Tare Creek	0.0003		Storm Runoff
5092	Texaco, Inc.	Cleveland	Petroleum Products	25	-		Cuyahoga	0.0004	0.0028	Storm Runoff
7391	General Tire & Rubber	Mogadore	Butadiene Polymers	26	-	0.10	Wingfoot Lake Outlet	0.03	0.01	Cooling
9349	City of Cleveland Water Plant	Cleveland	Water	-	-	-	Cuyahoga	1.29	-	Backwash Filter
9349	City of Cuyahoga Falls	Cuyahoga Falls	Water	-	-	-	Cuyahoga	0.29	-	Backwash Filter
9349	Akron Water Plant	Franklin Twp.	Water	40	-	-	Cuyahoga	1.0	-	Backwash Filter
None	Consolidated Natural Gas Services	Macedonnia	Repair Gas Meters	82	0.013	0.021	Tinkers Creek	0.0282	-	

TABLE C-I (cont'd)

Footnotes:

[a] Data taken from discharge permit application submitted to U. S. Army Corps of Engineers.

[b] Industry also classified as SIC No. 2815.

[c] Industry also classified as SIC No. 3729.

[d] Industry also classified as SIC No. 3069, 2818, 2821, 3714.

[e] Industry also classified as SIC No. 3079.

[f] Includes recycled flow.

[g] Industry also classified as SIC No. 3369.

[h] Industry also classified as SIC No. 3714.

[i] Industry also classified as SIC No. 3531, 3722, 3714, 3742.

[j] Industry also classified as SIC No. 3321, 3565.

[k] Includes boiler flow.

[l] Industry also classified as SIC No. 281.

[m] Industry also classified as SIC No. 34.

[n] Includes recycled flow.

[o] Industry also classified as SIC No. 493.

[p] Industry also classified as SIC No. 3522.

[q] Includes recycled flow.

TABLE C-II

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - CHAGRIN RIVER[a]

					Water Usage		Wastewater Discharge			
SIC NO	Name	Location	Products	Employment	Process (MGD)	Cooling (MGD)	Point of Discharge	Flow to River (MGD)	Flow to Sewer (MGD)	Type of Waste to River
1441	Penn. Glass Sand Corp.	Aurora	Sand	6	0.24	-	Aurora Branch	0.24	-	Process
208	Custom Beverage Packers	Aurora	Carbonated Soft Drinks	250	0.11	0.01	Ditch to Sunny Lake	0.025	-	Process
209	The Mogul Corp.	Bainbridge Twp.	Dry Biological Products	200	0.004	0.032	Unnamed stream	0.032	-	Cooling, Boiler
2621	Chase Bage Company	Chagrin Falls	Paper	120	1.5	0.164	Chagrin	1.66	0.0025	Cooling, Process
281	The Mogul Corp.	Bainbridge Twp.	Mogul Water	200	0.004	0.032	Unnamed Stream	0.003	-	
3079	Johnson Plastic Corp.	Auburn Twp.	Plastic Products	180	0.0008	0.0012	Ditch to Bridge Creed	0.0015	-	
3452	The National Screw & Mfg. Co.	Mentor	Fasteners	681	0.01	0.13	Drainage Ditch	0.01	0.09	
36	Picker Corp.	Highland	X-ray Equip.	1300	0.015	0.0147	Tributary to Chagrin	0.0657		Process
5092	Standard Oil Co.	Chagrin Falls	Gasoline	5	-	-	Unnamed Creek	0.0001	0.0003	Storm runoff

TABLE C-III

DATA FOR INDUSTRIES SUBMITTING APPLICATIONS
FOR DISCHARGE PERMITS - ROCKY RIVER[a]

SIC NO	Name	Location	Products	Employment	Water Usage: Process (MGD)	Water Usage: Cooling (MGD)	Wastewater Discharge: Point of Discharge	Wastewater Discharge: Flow to River (MGD)	Wastewater Discharge: Flow to Sewer (MGD)	Wastewater Discharge: Type of Waste to River
201	Akron Packing Co.	Richfield	Beef	75	-	-	Storm Sewer	0.005	-	Sanitary
203[o]	H W Madison Co.	Medina	Pickles	245	0.08	0.22	Bradway Creek	0.21	0.08	Cooling
2654	U.S. Plywood Papers Charpion	Cleveland	Milk Containers	247	-	0.034	Rocky River	0.049	-	Cooling, Sanitary
2813	Union Carbide Corp				0.01	0.01	Rocky River	0.0068	-	Cooling
3461[p]	Modern Tool & Die Co.	Liverpool Twp.	Lawn Mowers Tractors	300	0.02	0.01	Rocky River	0.025	-	Cooling, Process
4922	Columbia Gas Transmission Co.		Natural Gas Compressor	14	-	0.0015[q]	West Fork Rocky River	0.000225	-	Sanitary

ATTACHMENT D

WASTEWATER CHARACTERIZATION FOR SIGNIFICANT INDUSTRIES

This attachment contains summaries of wastes produced in the major industries located in the Study Area. Also summarized in these sections are characteristics of wastes for each industrial category used in the wastewater inventory. Employment figures for the various categories include only the portion of each county included in the Study Area. Employment figures used for estimating projected industrial waste loads were obtained from another source [52]. These values are listed in Attachment G.

SIC 20 - FOOD AND KINDRED PRODUCTS

The food and kindred products industry is engaged in the manufacture of food and beverages for human and non-human consumption. These industries employ approximately 4 percent of the Study Area work force. Most of these establishments are located in Cuyahoga and Summit counties. A summary of employment in food processing industries in the Study Area is shown in Table D-I.

Wastes from food processing operations are generally characterized by high BOD and COD concentrations and a wide range of suspended solids and oils depending on the particular food being processed. Nitrogen and phosphorus concentrations in food processing wastes vary over a wide range.

The meat products industry, SIC 201, is primarily engaged in the manufacture of beef, lamb, poulty, as well as various processed meats. The basic manufacturing process involves slaughtering, cutting, chilling, and further processing operations. Poultry processing also includes defeathering and eviscerating steps. By-products from the slaughtering, eviscerating, and cutting operations are shipped to a rendering plant. Potential sources of significant wastestreams are from the storage of the live animals in stockyards and pens and from various cleanup operations in the meat processing steps. Within this industry by-products are being recovered to minimize effluent loadings.

Dairy products industries, SIC 202, are engaged primarily in the production of various cheeses, frozen desserts and fluid

TABLE D-I

EMPLOYMENT FOR THE FOOD AND KINDRED PRODUCTS INDUSTRY

			County			
SIC	Cuyahoga	Lake	Medina	Portage	Geauga	Summit
2011	509	-	-	17	35	150
2013	675	-	-	-		60
2015	231	-	-	-	-	32
2022	36	-	-	-	35	-
2024	115	-	-			3
2026	1638	-	35	-	56	1031
2031	13				-	-
2033	82	-	-	1	-	32
2035	75	16	166			1
2036	371	-	-	-	-	-
2037	479		-			72
2041	50	-		21	-	40
2042	38		53	30	73	32
205	3060	15	-	-	5	869
2071	179	8				77
2072	10	-	-	-	-	-
2082	904			-	-	-
2084	34	4	-	-	-	-
2085	50	-				-
2086	1076	-	-	178	-	475
2087	141	-				2
2093	115	-	-	-	-	-
2094	209	-	-	-	-	12
2095	52	-	-	-	-	-
2097	63	-	-	-	-	13
2098	40	-	-	-	-	-
2099	493		-	-	2	159
Total	10738	43	254	247	206	3060

milks. Water is consumptively used in the products as well as in the pasteurizing process and in washing and cleanup operations. Because of the high BOD of milk and milk products, organic loadings from this category tend to be high, but may vary depending on measures taken to minimize spills and leakage.

Canned and preserved fruit, vegetables. industries are only significant within the Study Area in Cuyahoga County. Water is primarily used in the products as well as for washing of raw materials and cleanup operations.

Grain mill products industries, SIC 204, engage in the manufacturing of flour and grain and include products for human consumption as well as animal feed.. This category is not a significant employer within the Study Area. Water usage in these firms was reported to be very little in excess of sanitary use.

The majority of the water used within the bakery products industry, SIC 205, is used for cleanup; however, waste discharges have high BOD and COD concentrations because of the large amounts of starches and carbohydrates in bakery products. Candy and confectionary products industries, SIC 207, manufacture candy, confectionaries, chewing gums, and related products. Most of the water used in this industry is for cleanup purposes. The candy industry is not a significant employer within the Study Area.

Beverages industries SIC 208, manufacture various malt liquors, beers, wines, brandies, distilled and blended liquors,

distilled spirits, canned soft drinks and flavoring extracts and syrups. Since SIC 2082, malt liquors and SIC 2086, bottled and canned soft drinks, are the most significant SIC 20 industries in the Study Area, they will be further discussed.

The manufacturing of malt liquors entails grain cooking, mashing, settling - screening, boiling with hops, screening, storage, filtering and fermentation by yeast. Following fermentation, the surplus yeast and proteinaceous materials are filtered, and the malt liquor is carbonated and packaged. Water is consumptively used in the product and extensively used for cooling and equipment cleanup. The majority of the effluent flow originates in the packaging area, whereas the primary sources of BOD, and suspended solids are, respectively, from the brewing and fermentation-filtration operations.

Bottled and canned soft drinks manufacturing involves the blending of a flavored syrup and carbonated water within the primary container, sealing, and packaging. Water is consumptively used in the product as well as for cooling, bottle washing, and clean up operations. The major sources of wastewater are from the bottle washing operation and equipment cleanup. Waste flow and composition will vary significantly depending on whether or not bottles are washed for reuse. Apppropriate adjustments were made for soft drinks plants in the Study Area as required.

Miscellaneous food preparations and kindred products, SIC 209, involves the production of various vegetable and animal-marine oils,

coffee, ice, and miscellaneous foods and preparations. These industries are a significant employer in Cuyahoga County. Considerable water is used for cooling purposes in the production of various vegetable oils and potato chips.

The rendering process entails the grinding of animal carcasses, scrap materials, and offal followed by a cooking process and further processing for oils separation. The separation allows the production of various greases and inedible tallow products as well as animal feed and fertilizer by-products. Each process contributes to the plant wastes load.

Table D-II presents a delineation of the four-digit SIC 20 industries present in the Study Area. Also presented in this table are constituent concentrations for each industrial category.

SIC 22 - TEXTILE MILL PRODUCTS

Textile mill products industries manufacture and process a variety of natural and synthetic fibers. Major sites of manufacturing are located in Cuyahoga and Lake Counties. Employment for the textiles industry in the Study Area is shown in Table D-III.

Typical Manufacturing Processes, Water Usage, and Waste Sources

Industries in SIC 223, broad woven wool fabric mills, have as their primary input, raw wool. This wool is scoured, dyed, carded, fulled, washed, carbonized, piece dyed, bleached, and brightened. Frequently the wool is scoured in separate mills.

TABLE D-II

WASTEWATER CHARACTERISTICS FOR THE

FOOD AND KINDRED PRODUCTS INDUSTRY

SIC	Description	BOD mg/l	COD mg/l	SS mg/l	TDS mg/l	Oil & Grease mg/l	TKN mg/l	P mg/l
2011	Meat Packing	1100	1800	972	715	720	100	10
2013	Sausage	900	1700	630	715	300	100	10
2015	Poultry	1100	1800	650	900	72	230	32
2022	Cheese	1900	2400	200	1500		100	25
2024	Frozen Desserts	1900	2400	200	1500		100	25
2026	Fluid Milk	1900	2400	200	1450		60	14
2031	Canned & Cured Fish	1050	2100	600	3500	300	400	500
2033	Canned Fruit	1800	2800	750	3950	30	150	40
2035	Pickled Fruits & Vegetables	2400	3200	700	3950	30	150	40
2036	Fresh or Frozen Fish	1000	2100	700	3650	30	380	550
2037	Frozen Fruits	570	1400	575	4000	-	10	40
2041	Flour	-	-	-	-	-	-	-
2042	Prepared Feeds	-	-	-	-	-	-	--
2051	Bakery Products	9600	32000	6300	11300	30	70	200
2071	Candy	2600	3500			100	-	-
2072	Chocolate	-	-	-	-	-	-	-
2082	Malt Liquors	1600	2950	770	-	-	64	16
2084	Wine, Brandy	2000	3000	190	-	-	5	25
2085	Distilled Liquor	1000	1000	-	-	-	5	25
2086	Soft Drinks	500	1800	300	3200	-	3	4

TABLE D-II (cont'd)

WASTEWATER CHARACTERISTICS FOR THE

FOOD AND KINDRED PRODUCTS INDUSTRY

SIC	Description	BOD mg/l	COD mg/l	SS mg/l	TDS mg/l	Oil & Grease mg/l	TKN mg/l	P mg/l
2087	Flavoring Extracts	300	1300	75	1270	-	50	25
2093	Vegetable Oil Mills	6250	12500	1500		-	150	25
2094	Animal & Marine Fats	1500	14000	1000	500	300	150	3
2095	Coffee	1700		900			150	25
2097	Ice	-	-	-	-	-	-	-
2099	Food Preparations	1200	3900	2140	1520	29	81	15

TABLE D-III

EMPLOYMENT FOR THE TEXTILES INDUSTRY

SIC	County: Cuyahoga	Lake	Portage	Summit
2231	275	-	-	-
2253	1229	550	-	-
2261	35	-	-	-
2269	259	-	-	-
2271	-	-	-	-
2279	-	-	36	-
2281	10	-	-	-
2283	105	-	-	-
2294	91	-	-	11
2295	-	-	23	4
2296	15	-	-	-
2298	23	-	-	-
Total	2042	550	59	15

Scouring is a cleaning process using detergents or solvents Carding is a mechanical step used to align or parallel fibers. Fulling is used to impart a felt quality to the wool. During carbonizing fabric organic impurities are removed by sulfuric acid impregnation, heating, mechanical dusting, followed by rinsing with a sodium carbonate solution to neutralize residual acid. During the weaving operation water is used in scouring and slashing. Rescouring, dyeing, fulling, washing, carbonizing and bleaching are all finishing steps involving the use of water. The scouring step contributes BOD, grease, alkalinity, and color. Other major wastes are generated during the dyeing and washing operations, contributing BOD and color and oil, respectively, to the process wastestream.

Processing in knitting mills, SIC 225, is similar to the aforementioned SIC 223 industry with the exception that knitting operations replace the woolen weaving step. This industry is the largest employer relative to the SIC 22 industries in the Study Area.

Dyed and finished textiles except for fabrics and knit goods industries, SIC 226, process primary woven or knitted cloth. The typical manufacturing processes for SIC 226 industries entail the operations of cloth desizing, bleaching, mercerizing, dyeing, printing, and finishing. Of these processes typically only the printing and finishing operations do not significantly contribute loading to the plants effluent wastestreams.

Yarn mills, SIC 228, manufacture wool and synthetic yarns. The processes used are essentially carding, spinning, scouring, dyeing, and washing with or without sizing. Water is used in the scouring, dyeing and washing processes. This industry is a relatively small employer in the Study Area.

Miscellaneous textile goods, SIC 229, includes industries involved in processing recoverable fibers, tire cord, cordage and twines, artificial leathers, oil cloths, various metallic and paper fibers and felt goods. Manufacturing processes used in these industries and wastestreams produced are highly product specific. The recovered fibers industry is the most significant SIC 229 industry in the Study Area and is centered primarily in Cuyahoga County. Average raw waste loads for textile industries are in Table D-IV.

SIC 26 - PAPER AND ALLIED PRODUCTS

Cuyahoga County contains approximately 85 percent of the SIC 26 industrial work force within the Study Area. However, SIC 26 industries do not employ a significant portion of the total work force in Cuyahoga County or within the entire Study Area, having respective percentages of 1.7 and 1.4 for each. A delineation of number of employees within each four digit SIC 26 category by county is given in Table D-V.

TABLE D-IV

WASTEWATER CHARACTERISTICS OF THE TEXTILE INDUSTRY

SIC	Description	TDS mg/l	BOD mg/l	COD mg/l	SS mg/l	Oil & Grease mg/l	Nitrogen mg/l	Phosphorus mg/l
2231	Wool Fabric Mills	1500	450	100	170	-	15	15
2253	Knit Outerwear	1500	340	700	34	-	15	10
2261	Cotton Fabric Finishing	1500	500	800	170	-	-	-
2269	Textile Finishers	2000	450	1800	170	-	10	9
2281	Yarn Spinning	-	-	-	-	-	-	-
2283	Wool Yarn Mills	1500	510	1800	520	-	27	27
2294	Recovered Fibers	1500	510	2100	170	-	9	9
2296	Tire Cord & Fabric	-	-	-	-	-	-	-
2298	Cordage & Twine	-	-	-	-	-	-	-

TABLE D-V

EMPLOYMENT FOR THE PAPER INDUSTRY

SIC	County					
	Cuyahoga	Summit	Lake	Portage	Medina	Geauga
2621	160	74	-	-	-	-
2631	160	92	-	-	-	-
2641	136	320	-	-	-	-
2642	423	-	-	-	-	-
2643	243	103	-	-	-	-
2644	75	-	-	-	-	-
2645	227	7	-	-	-	6
2647	-	-	-	-	-	-
2649	159	16	-	-	-	-
2651	547	-	-	-	-	-
2652	484	-	-	39	-	-
2653	1241	47	77	-	58	-
2655	386	-	-	-	-	-
Total	4241	659	77	39	58	6

Typical Manufacturing Processes, Water Usage, Wastewater Sources

SIC 26 industries within the Study Area include plants producing paper, corrugated paperboard, and bogus as well as numerous varieties of specialty paper products.

Paper mills except building paper mills, SIC 262, within the Study Area have pulp stock as their primary raw input. This raw pulp is first mechanically and/or chemically treated. "Furnish," the mixture of water, raw pulp, and chemicals, is blended, then undergoes a beating-pulping step with subsequent refining and storage prior to being fed to the paper machine. The beating and refining operations separate fiber and improve the formability of the paper. During the pre-paper machine phase, water is used to purge rejects from cleaners, for equipment washout, and also when wastage of unacceptable furnish occurs. The paper machine produces finished paper products from the input furnish by a series of sequential rolling operations. Various texturing, coloring, and coating operations can be accomplished within the paper machine. A white water is produced from the dewatering of the furnish in the paper machine. Savealls are used to recover fibers and filler materials. The liquid from the saveall is usually recycled to the paper machine, the furnish makeup, and to the process wastestream. Most finishing and converting operations are dry processes except where wet coating procedures are being used. Wastewaters specific to individual products are generated during the coating operation.

Paperboard mills, SIC 263, manufacturing is similar to that previously discussed for the production of paper. Water usage and waste sources are also similar to those present in a paper mill. The several SIC 263 plants in the Study Area are not major employers.

SIC 264, miscellaneous specialty paper products industries purchase primary paper and manufacture various glazed and coated papers, envelopes, bags, wallpapers, paper boards, cardboards, sanitary paper products, and converted paper products. Contaminated flow resulting from these processes is minimal; therefore, no waste load was attributed to industries in this category.

Plants engaged in the manufacture of paper boxes and cans, drums, and similar products purchase raw paperboard and further process it to produce a variety of paperboard boxes, corrugated and solid boxes, sanitary food containers and fiber cans, tubes and drums. Within the Study Area, the vast majority of the SIC 26 work force are employed in SIC 265 industries and are primarily located in Cuyahoga County. These manufacturing processes use no significant quantities of water.

Characterization of Wastewaters within the Paper Industry

Wastewater characteristics for the paper industry, prior to waste treatment are summarized in Table D-VI for each four-digit SIC 26 industrial category. Only those industries having a process wastestream are listed. As shown, only the paper mills, coating and galzing and bag manufacturing industries have significant process wastestreams.

TABLE D-VI

WASTEWATER CHARACTERISTICS FOR THE PAPER INDUSTRY

SIC No.	Description	BOD mg/l	COD mg/l	SS mg/l	Nitrogen mg/l	Sulfate mg/l
2621	Paper Mills	70	280	110	3	175
2631	Paperboard Mills	-	-	-	-	-
2641	Coating & Glazing	2	4	12	-	-
2642	Envelopes	-	-	-	-	-
2643	Bags	120	250	350	-	-

SIC 28 - CHEMICALS AND ALLIED PRODUCTS

Approximately 3 percent of the labor force in the Three Rivers Watershed area is employed by the chemical industries. Of these 11,600 persons, 94.8 percent are employed in Cuyahoga, Summit and Lake counties. The main contributors to the waste flow in this industry are the two large chemical companies in Cuyahoga County.

The chemical industry is characterized by its great diversity in chemical products, processes, and wastes. The number of chemicals commercially produced reaches into thousands, each having its particular variants in the manufacturing process. The industry is constantly changing, using different raw materials and new processes, and producing new products. The highly diversified nature of the chemical industry makes a meaningful estimation of the wastes produced a formidable task. As an example, SIC 2819 includes the production of all industrial inorganic chemicals. Wastewaters produced in this category could include a wide range of inorganic chemicals. Most treatment facilities in the chemical industry must be individually designed to conform to the specific characteristics of the waste produced in the industry.

The three-digit categories in the chemical industry and the specific products produced in these categories are summarized in Table D-VII. The categories of prime importance in the Study Area are 281, 282, 285, and 289. A summary of employment in these various three digit categories is also shown in this table.

TABLE D-VII

SUMMARY OF EMPLOYMENT IN THE CHEMICAL INDUSTRY

SIC	Description	County						
		Cuyahoga	Summit	Lake	Portage	Medina	Geuga	Total
281	Basic industrial inorganic and organic chemicals	1,538	177	68	-	20	-	1,803
282	Plastic materials and synthetic resins, synthetic rubbers, and cellulosic and man-made organic fibers	200	1,158	-	-	18	140	1,516
283	Medicinal chemicals and pharmaceutical products	355	-	-	-	-	91	446
284	Soaps, detergents, and cleaning preparations, perfumes, cosmetics, and other toilet preparations	506	119	-	-	3	6	634
285	Paints, varnishes, lacquers, enamels, and allied products	2,805	58	35	16	203	7	3,117
287	Fertilizers, agricultural,pesticides, and other agricultural chemicals	131	20	7	-	-	-	158
289	Gelatin and industrial and household adhesives, glues, sizes and cements, explosives	2,415	297	1,078	36	-	6	3,832
Total		7,950	1,829	1,188	52	244	250	11,556

Chemical Industries in the Study Area

Seventeen firms having employment greater than 200 account for only 49 percent of the total chemical industry employment in the Study Area. The remaining 51 percent of the employees are divided among 291 small firms with an average of 21 employees per firm. The most significant of these industries include industrial gases (2813), cyclic intermediates (2815), industrial organic chemicals (2818), industrial inorganic chemicals (2819), plastics materials, synthetic resins, and non-vulcanizable elastomers (2821), vulcanizable elastomers (2822), and paints, varnishes, lacquers, enamels, and allied products (2851). Other significant industries in the area include those which manufacture explosives (2892) and miscellaneous chemicals and chemical preparations (2899).

Many firms producing organic and inorganic chemicals, SIC 281, manufacture products in several four-digit categories. The principal products manufactured by industries in this category are chemical catalysts, cyclic intermediates, chromium chloride, nickel sulfate, nickel chloride, ammonium bifluoride, anhydrous hydrofluoric acid, sulfuric acid, sulfates, hydrochloric acid, chlorides, and soluble silicates.

Because of the diversity of products manufactured by these industries, a complete evaluation and inventory of this category was beyond the scope of this study. However, large chemical companies which produce the greatest portion of wastewater in these categories were investigated.

Synthetic rubber, SIC 2822, is manufactured by mixing butadiene with some other monomer such as styrene or acrylonitrile plus a catalyst, in a soap solution, to produce synthetic latex. Coagulation of the latex either in an acid-brine solution or with alum follows, after which the latex is washed, dried, and baled. Waste from the synthetic rubber plant consists of whatever coagulated rubber escapes, plus the acid and saline liquid, and occasional batches of materials which do not polymerize properly.

Another major category in the chemical industry is the manufacture of paints, SIC 2851. The first step in the manufacture of paints is the weighing, assembling, and mixing of pigments in batches. These batch masses are then processed in a series of grinding mills. These batches are then thinned and tinted in agitated tanks. Next, the liquid paint is strained into a transfer tank or directly into the hopper of the filling machine. Centrifuges, screens, or pressure filters are used to remove nondispersed pigments. The paint is then poured into cans or drums, labeled, packed, and moved to storage.

Vanishes are solutions of a resin to which have been added dryers and thinners. The manufacturing procedure varies widely, depending on the types of oil or resin used. Occasionally, volatile solvents are used in place of oil. Some of the natural resins are insoluble in oil and must be depolymerized by heating. The pretreated drying oil is then added, and the heating continued to the correct viscosity. The mixture is then cooled and the thinner and drier are added. The preheating step is omitted in the case of synthetic resins.

The varnish is then clarified by filtration or centrifugation, followed by aging in large tanks to precipitate fine gel particles not removed in the previous operations.

The standard raw waste loads associated with each of these industries is given in Table D-VIII. Because of the diversity of this industry, only the categories listed in this table were included in the inventory. However, these categories comprise the great majority of the waste load produced in the chemical industry.

SIC 29 - PETROLEUM INDUSTRIES

Of the 1,709 employees in the petroleum industry, approximately 92 percent are employed in Cuyahoga County. The four-digit categories represented in the Study Area are 2911, petroleum refining; 2951, paving mixtures and blocks; 2952, asphalt felts and coatings; and 2992, lubricating oils and greases. A summary of employment in these various categories is shown in Table D-IX.

There are three main plants in category 2911. The largest of these has a total employment of 96. The activities of these plants include blending of asphalt felts, reclamation of used industrial oils, and blending of refined lubricants with other lubricants to make specific products. No plants are engaged in large-scale oil refining. Although wastes produced in these industries contain significant amounts of contaminants, water usage in the industry is low.

TABLE D-VIII

WASTE LOADS PRODUCED IN CHEMICAL INDUSTRIES

SIC	Description	BOD mg/l	COD mg/l	TDS mg/l	SS mg/l	Oil mg/l	N mg/l	P mg/l	Cu mg/l	Cr mg/l	Cd mg/l	Ni mg/l	Zn mg/l	Fe mg/l
281[ab]	Organic & inorganic chemicals	-	-	2284	3172	10	21	-	0.4	-	-	0.9	0.2	2
281[b]	Organic & inorganic chemicals	-	214	924	55	50	124	-		2	-	-	138	-
2822	Synthetic Rubber	300	1900	5400	1400	21	1.5	2.8		-		-		-
2851	Paints	238	582	339	-	29	-	-	0.1	0.2	0.4	0.1	0.3	0.9

a The following concentrations of constituents in mg/l are also included in this category: Cl, 449 mg/l; F, 34 mg/l; Ba, 0.49 mg/l; B, 1.30 mg/l; Ti, 5.0 mg/l; Co, 0.78 mg/l, Al, 7 mg/l.

b Because of the diversity of this industry, two raw waste loads indicative of large chemical producers in the area are presented.

TABLE D-IX

SUMMARY OF EMPLOYMENT IN THE PETROLEUM INDUSTRY - SIC 29

SIC	Cuyahoga	Summit	Lake	Portage	Medina	Geauga	Total
2911	134	-	-	-	-	-	134
2951	138	41	-	-	4	4	187
2952	640	-	30	-	50	-	720
2992	661	7	-	-	-	-	668
Total	1573	48	30	-	54	4	1709

The industries in SIC 2951 manufacture asphalt, asphaltic concrete, and semi-refractory hot taps for the steel industry. Asphalt, obtained as a residue from the regular refining process, is found in a variety of types and grades ranging from hard brittle solids to almost water-thin liquids. The main uses of water in this category are for steam production, cooling water, and dust control. No significant contaminated discharge is produced in these plants.

A third category of importance is SIC 2952. These companies mix and package roof coatings and specialty paint products. The main water use in this area is for cooling in refrigeration units and compressors. A small quantity of oil present in waste discharges originates from spills.

Another important category is SIC 2992. The products manufactured in this area fall into three general classes; mixtures of mineral oil and solid lubricants; blends of waxes, fats, resin oils, and pitches; and soap-thickened mineral oils. Water is used for heating, cooling, and process use.

Table D-X presents a summary of the estimated raw waste loads for the various categories in the petroleum industry. Values found in Dalton-Dalton Study [7] were compared to available literature.

SIC 30 - RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS

The rubber and miscellaneous plastic products industry, SIC 30, employs 13 percent of the total Study Area work force and is located

TABLE D-X

WASTE LOADS PRODUCED IN PETROLEUM INDUSTRIES - SIC 29

SIC No.	Description	BOD mg/l	COD mg/l	TDS mg/l	SS mg/l	Oil mg/l	N mg/l	P mg/l	Phenol mg/l
2911	Petroleum Refining	20	70	200	35	40	-	-	-
2951	Paving Mixtures	-	-	-	-	-	-	-	-
2952	Asphalt & Coatings	38	111	-	-	5	-	-	1
2992	Lubricating Oils	10	150	1700	300	30	-	10	15

predominantly in Summit County. Included in this classification are industries that manufacture finished rubber and plastic products. The actual production of rubber copolymers and crumb from monomers is classified as a section of the chemical industry, SIC 28. Category 3011 entails the manufacture of casings, inner tubes, and numerous varieties of solid and pneumatic tires. This category contains the largest number of employees and is primarily located in Akron. SIC 3031 involving the use of reclaimed rubber has the least employment of these several classifications. The major employer in this category has a combined SIC 3031 and 3011 operation; therefore, SIC 3031 will be included inthe SIC 3011 category in subsequent considerations. The fabricated rubber products industry, SIC 3069, is primarily engaged in the manufacturing of various industrial and domestic rubber goods. Rubberized fabrics, various rubber specialty products, and industrial mechanical rubber goods are produced within this category. Miscellaneous plastic products plants, SIC 3079, primarily manufacture moded primary plastic products to be used within the rubber and chemicals industries, but also assemble various finished plastic products. Employment within the SIC 30 category for the Study Area is shown by country and four-digit SIC category in Table D-XI.

Rubber and Miscellaneous Plastic Products Industries in the Study Area

The largest SIC 30 category employers within the Study Area are the five major tire and rubber manufacturers located in Akron. These

TABLE D-XI

EMPLOYMENT FOR THE RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS INDUSTRIES

		Counties						
SIC No.	Description	Cuyahoga	Summit	Lake	Portage	Medina	Geauga	Total
3011	Tires	-	37373	2		-	-	37375
3031	Reclaimed Rubber	-	515	-	-	-	-	515
3069	Fabricated Rubber	874	2025	1557	1172	538	1674	10718
3079	Miscellaneous Plastics	3672	1340	118	1382	55	614	8056
Total		4546	41253	1677		593	2288	56664

plants are the Goodyear Tire and Rubber Co., General Tire and Rubber Co., B. F. Goodrich Co., Firestone Tire and Rubber Co., and the Mohawk Rubber Co. Each of these plants are classified as manufacturers of tires and inner tubes; however, considerable changes have occurred within these plants in the last few years. In addition to tires and inner tubes, products produced in these plants include fabricated rubber products, SIC 3069, plus several extraneous categories related to the rubber products industry such as the production of raw rubbers and metal products, principally metal tire rims. The effluent flow as well as employment for this specific plant were included entirely in SIC 3011 although only a portion of its production is classified as SIC 3011.

Rubber and miscellaneous plastic products industries are particularly significant in Geauga and Portage counties, respectively, accounting for 50 and 20 percent of each county's manufacturing work force.

Source of Waste in Rubber and Miscellaneous Plastics Manufacturing Processes

Several distinct significant manufacturing processes will be discussed. These processes are the manufacturing of tires and inner tubes, the processing of reclaimed rubber, the manufacturing of fabricated rubber products, and the manufacturing of miscellaneous plastic goods.

Tires and Inner Tubes. The manufacturing of tires and inner tubes begins by blending several raw materials (natural and/or sunthetic rubber, carbon black, sulfur, reclaimed rubbers, and other chemicals such as various plasticizers and accelerators) in a Banbury mixer. Considerable heat is generated during this blending-mixing and mastricating. Therefore, a significant portion of the plant total cooling water is used in this operation. This mixing operation contributes suspended solids and color to the plant effluent. A soapstone solution (clay, soap, and water), is sprayed on the rubber during its transfer by conveyor from the mixer to the milling operation. During this transfer the rubber is quenched on the cooling conveyor and cut into specific lengths. The transfer process supplies suspended solids, color, soap, and oil and grease to the process waste-stream. The rubber is then milled, strained, and remilled. Only cooling water and oil and greases are discharged from this operation. The rubber material from the milling operation can be used for a variety of refining steps. In the manufacturing of tires, the rubber is fabricated on a collapsable, circular rotating drum. Layers of fabric (nylon, rayon and steel) are cross-layered in opposite directions to tie the beads together. The beads are united to the tire by folding the fabric over and stitching through the tire sidewall. Extruded treading is then laid on and the ends connected. The tire is then placed in a press with an inflatable rubber pneumatic bag placed in the center to mold the tire. Steam is applied

through the mold and into the inner bag to cure the green tire. The curing operation produces primarily suspended solids and oils and greases to be discharged to the process effluent wastestream.

After curing, black-walled tires are stored, whereas white-walled tires are passed through a grinding operation to expose the white layer. The white wall is then given a protective outer spraying, wrapped, and stored. During the grinding operation suspended solids are discharged to the plant wastestream.

In producing inner tubes or hosing, the rubber from the milling operation passes through a tuber in which it is extruded to produce inner tubes or hosing. From the tuber the hosing or inner tube undergoes specific fabrication, through a curing step, and is packaged and stored for shipment. No significant waste loads are introduced from the tubing processing.

Reclaimed Rubber. Reclamation of spent rubber goods is accomplished by shredding the spent rubber in hammer mill and discharging the residue on a conveyor where metallic materials are removed magnetically. The remaining rubber-fabric particles are freed of their entrained fabric by mechanical or chemical treatment in caustic solutions at high temperatures for several hours. After washing the rubber particles are ready for recycling.

Fabricated Rubber Products. Industries producing fabricated rubber products are highly product specific with respect to the manufacturing processes employed and wastewaters produced. Overall,

these industries have manufacturing processes dealing with molding and manipulations of composited and rubber blended goods. Waste generated from these processes are usually suspended solids and small amounts of oil and greases.

Miscellaneous Plastic Goods. Raw primary plastics are used in a variety of extrusion and molding-casting operations to produce intermediate or final processed plastic goods. Wastes are generated by the required product trimming, deburring, painting, and, in some cases, plating. Painting and plating operations will usually significantly increase the plant effluent wastewater characteristics with respect to its content of suspended and dissolved solids, solvents, acids, paints, and metals. Therefore, the effluent characteristics are highly contingent upon the specific processing being used.

Water Usage and Wastewaters Generated Within the Rubber and Miscellaneous Plastics Industries

The five major tire and inner tube manufacturers in the Akron area are taking the majority of their input water from surface waters. These plants use the vast majority of their waterfor cooling purposes. Four of the five plants are discharging their cooling waters to surface waters. Each of these five plants are discharging all their sanitary wastes, and in some cases, their process waters to the Akron municipal sewerage system. Data collected by the City of Akron was used to arrive at estimated waste loads for this industry. Rubber and

plastics products industries do not contribute a relatively significant portion of the loading to other municipal combined systems in the remaining cities in the Study Area. Those wastewaters being discharged to municipal sewers primarily contain suspended rubber particles and oil and greases.

An overall assessment of wastewaters contributed by the rubber and miscellaneous plastics industries in the Study Area as delineated by four-digit SIC categories are shown in Table D-XII. As shown, the major impact of the SIC 30 category industries is due to the discharge of wastes from tires and inner tubes industries to the combined municipal sewer system in Akron.

SIC 33 - PRIMARY METAL INDUSTRIES

Primary Metal Industries in the Study Area

Primary metals industries in the Study Area employ approximately 11 percent of the total manufacturing work force in the six major counties of the Study Area. Of the 42,200 persons employed in these categories, approximately 97 percent work in either Cuyahoga or Summit Counties. Approximately 16,000 persons, or 38 percent of the workers in these industries, are employed by the large steel companies in Cleveland. A summary of employment by three-digit classifications in the primary metals industry is shown in Table D-XIII.

The largest employers and water users in SIC 33 within the Study Area are the three major steel companies in Cleveland. Jones

TABLE D-XII

WASTEWATER CHARACTERISTICS FOR THE RUBBER AND

MISCELLANEOUS PLASTIC PRODUCTS INDUSTRIES

SIC No.	Description	BOD mg/l	COD mg/l	SS mg/l	Oil mg/l	T D S mg/l
3011	Tires and Inner Tubes	50	100	50	-	-
3031	Reclaimed Rubber	6000	12000	12000	-	8000
3069	Fabricated Rubber Products	-	-	20	-	-
3079	Miscellaneous Plastic Products	10		175	-	-

TABLE D-XIII

EMPLOYMENT BY COUNTIES FOR PRIMARY

METALS INDUSTRIES (SIC 33)

SIC	Description	Cuyahoga	Summit	Lake	Portage	Medina	Geauga	Total
331	Steel mills	17281	147	-	-	68	-	17496
332	Iron & Steel foundries	6048	1007	-	275	-	-	7330
333	Primary smelting, nonferrous metals	520	100	-	-	-	-	620
334	Secondary smelting, nonferrous metals	1227	-	-	-	-	-	1227
335	Rolling, extruding, nonferrous metals	3722	57	141	-	-	-	3920
336	Nonferrous foundries	7380	101	64	140	276	1	7964
339	Primary metal products	3341	70	162	66	7	9	3655
Total		39519	1482	367	481	351	10	42212

and Laughlin, U.S. Steel, and Republic Steel all have extensive steel making and rolling mills on the Lower Cuyahoga River. The Republic Steel Bolt and Nut Division, also located in Cleveland, is included in SIC 34. Other primary metal industries in the Study Area are much smaller than the steel mills but much more numerous. While the three steel mills in the area employ approximately 16,000 people at the present time, employment in the 180 other primary metal industries averages 125 persons. The most significant of these industries include gray iron foundries (SIC 3321), aluminum casting establishments (SIC 3361), and iron and steel forgings (SIC 3391). Other industries of significant size within this classification include smelting of nonferrous metals (SIC 3341), rolling and extruding of copper (SIC 3351), malleable iron foundries (SIC 3322), and other primary metal products (SIC 3399).

Sources of Waste in Manufacturing Processes

For purposes of relating sources of wastes to steel making processes, four basic manufacturing operations have been identified. These include the manufacture of coke in the by-products process, iron production using the blast furnace, steel manufacturing with the basic oxygen, open hearth and electric arc furnaces, and further processing in hot and cold rolling mills.

Coke Manufacturing. The manufacture of coke using the by-product process involves the heating of coal in the absence of air to produce coke and various volatile by-products. Necessary heat

for the process is supplied by the combustion of fuel in flues located between adjacent ovens. As the coal is heated to about 2000°F, volatile matter including ammonia, tar, naphthalene, light oils, phenol, cyanides, water vapor, and escapes as a hot gas. Condensates of these products constitute the major portions of wastes originating from the process. At the end of the 16-24 hr coking cycle, coke is pushed from the oven and quenched with a water spray. Water used for quenching is generally reused so that no significant wastes are generated in this part of the process.

The hot gases resulting from the distillation process are initially cooled by direct spraying with a flushing liquor. Subsequently, the partially cooled gas if further cooled in the primary cooler. Cooling water is indirectly applied to the gas in this step, so that little contamination of water results from this step if care is taken to keep cooling coils free of leaks. The flushing liquor which contains a large amount of the tar volatilized from the coal and the primary cooler condensate is pumped to a decanter in which the tar is separated from the liquor. Flushing liquor is recirculated and the only waste resulting at this point is the blowdown from the decanter. This waste is further treated in an ammonia still. Ammonia gas resulting from this greatment step is reintroduced to the primary-cooled gas stream for subsequent recovery in some plants. The ammonia stripped effluent from the still

is passed to a phenol recovery unit. This waste stream contains high concentrations of ammonia and phenol and is pumped to other waste treatment units.

Ammonia from the partially cooled gas stream and the ammonia still vapor is recovered and the remaining gas flows to the final cooler. At this point water is directly sprayed into the gas again. Naphtha condenses in the water and is separated; the water passes through a cooling tower, then recirculated to the final cooler. Next, light oils are scrubbed from the gas and fractionated for sale as by-products.

Additional sources of waste in the coke manufacturing process include blowdown from the final cooler water system and indirect cooling water which may become contaminated. Condensed steam and cooling water from the benzol recovery system may be recirculated to the coke quenching system. Additional constituents which may become waterborne in the coke making process include suspended solids and dissolved solids such as sodium, chloride, sulfate, fluoride, and sulfide. However, these substances are usually small and are not reported in standard waste loads.

The standard raw waste load for the by-product coke process is shown in Table D-XIV. The cooling water flow used in coke manufacture may be considerably lower depending on recirculation practiced in the plant. The waste loadings may also be considerably different if wastewaters are used in a closed quench system. In this

TABLE D-XIV

WASTE LOADS PRODUCED IN STEEL MILLS[a]

Process	Cooling gal/tn	Process gal/tn	SS mg/l	Oil mg/l	Fe[b] mg/l	Phenol mg/l	CN mg/l	NH_3-N mg/l
Coke	1,000	500				5	12	14
Blast Furnace	6,800	2,200	3,000			1.0	5	15
Steel								
BOF	1,000	200	24,000					
OHF	3,700	300	10,000					
Electric Arc	5,500	200	6,000					
Hot Mills	500							
Bloom		150	1,000	10				
Slab		150	2,000	30				
Billet		250	500	55				
Bar		900	200	15				
Hot Strip		750	575	40				
Hot Scarf		150	5,000	50				
Cold Mill								
Pickle Rinse[c]		500			1,000			
Tandem Mills		1,700	150	40[d]				

[a]Obtained primarily from the EPA industry profile [43] and the Cost of Clean Water [32].

[b]Although suspended solids consist primarily of iron fines, iron concentrations were not included in raw waste loads except in the case of pickle liquors.

[c]Effluent also contains 1,500 mg/l as $CaCO_3$ acidity and 600 mg/l of Cl or SO_4 depending on the acid used in the pickling process.

[d]Oil concentration will be approximately 300 mg/l if oil is not recirculated.

case, a substantial portion of the soluble wastes may be adsorbed to the coke and appear as wastes from the blast furnace.

Blast Furnaces. Iron is produced in the blast furnace utilizing iron ore, coke, and limestone as raw materials. Coke burned in the presence of air produces carbon monoxide which reacts with the ore to produce carbon dioxide and iron. Heat generated by the burning coke liquifies the iron and impurities in the ore which combine with limestone to form slag.

The only water used directly in blast furnace operations is cooling water which is usually uncontaminated except for an approximately 5°F temperature rise. This water may be recirculated in conditions warrant reuse. Considerable amounts of water are used in controlling airborne contaminants present in off-gases. Wet scrubber are usually placed at an intermediate position between dry dust separators and precipitators. This water contains large amounts of flue dust which is largely removed in thickeners and reused in the furnaces and some phenol and nitrogen compounds present in the coke.

Water used for quenching slag usually contains small concentrations of sulfides. However, these concentrations are generally not quantified in calculations of waste loads presented in available literature. Runoff from material storage areas usually contains suspended solids which may need to be removed from this water before discharge to surface waters.

Other contaminants which may result from blast furnace operations include COD, oils, and dissolved inorganic substances including aluminum, lead, manganese, sodium, potassium, iron, calcium, magnesium, nitrate, phosphate, sulfate, sulfide, fluoride, and chloride. The concentrations of these ions which vary according to the raw materials used and the quenching process used in making coke generally are small and are not included in standard waste loads. Industry-wide averages for wastes produced in the blast furnace are shown in Table D-XIV. Cooling water requirements varied from 3,500 gal/tn reported in the EPA industry profile [43] to 6,800 gal/tn used in the Cost of Clean Water series [32]. The latter value was used in this study because it more accurately reflected water use practices at the steel mills in Cleveland.

Steel Manufacturing. The most widely used methods of producing steel include the electric arc, open hearth, and basic oxygen furnaces. The basic differences in these processes relates to the manner in which heat is applied to the furnaces. In the BOF pure oxygen passed through the furnace reacts exothermically with the charge. In the open hearth process, the charge is heated indirectly by burning fuels around the outside of the furnace. As the name implies, heat is furnished in electric arc furnaces by passing an electric current through the metal. The raw materials required which include iron, scrap steel, limestone, lime, fluorspar, dolomite, iron ores, and various alloying substances are basically the same for each process.

Wastes produced in these processes are also similar for the various manufacturing methods; these wastes consist mainly of slag, carbon monoxide and dioxide gases, iron oxides emitted as dust. Other substances which may be found in wastewaters depending on the nature of raw materials used and on the specific alloying substances added to the charge include aluminum, chromium, nickel, lead, zinc, manganese, calcium, magnesium, silicon, copper, nitrate, phosphate, and sulfate.

The airborne wastes contained in the off-gases of these processes are removed by Venturi scrubber or precipitators. Waterborne wastes may also be generated if these gases are quenched in a water spray and when precipitators are flushed with water. Additional sources of waste associated with steel making arise from steel scale and oils introduced from teeming (casting of steel into ingots) and continuous casting operations, scrubbing waters from slag crushing. Major water usage in steel furnaces is for cooling; less than 10 percent is classed as process water. These flows are shown for the three basic furnaces in Table D-XIV.

Rolling Mill Operations. A wide variety of operations are used to produce intermediate and finished products from steel produced in the furnaces. However, the waste from these processes can adequately be described by discussing hot forming, cold forming, and pickling processes. In hot forming operations, steel ingots are reheated to a uniform temperature, then deformed to various shapes.

The most significant wastes produced in these processes include scale and oils used in lubrication of the mills. Following removal of suspended solids, water can be extensively reused.

Further processing of steel shapes is frequently accomplished in cold finishing operations. Processes included in these operations are cold rolling, drawing of wire and tubes, forming of nails, and casting of finished products. Wastewaters from these processes include cooling water, oil-water lubricants, and plating wastes. Rolling solutions may be recirculated by removing mill scale which collects through use. Considerable volumes of water used for direct cooling may contain small amounts of oil and submicron particles.

The removal of dirt, grease, and oxide coatings and scale by pickling in an acid solution generally preceeds cold finishing operations, but may also be practiced at other points in the manufacturing processes. Wastes produced in this operation include spent pickle liquors and rinse waters. At the present time, the steel companies in Cleveland have spent pickle liquor hauled away for disposal while rinse waters are handled at the mill site.

Other constituents frequently found in rolling mill wastes include COD, acidity from pickle rinses, iron, cyanide, phenol, ammonia, sulfate, chloride, and metals from alloys or plating solutions such as chromium, zinc, lead, cadmium, copper, and nickel. Water requirements summarized in Table D-XIV show that approximately 500 gal/tn is used for pickle rinses and 1,700 gal/tn for cold rolling. Requirements

for hot rolling processes vary between 150 and 900 gal/tn for process water and approximately 500 gal/tn for cooling when in-plant recirculation is practiced. The major constituents of these wastes include oils, iron, acid, and either chloride or sulfate in pickle rinse solutions.

Other Primary Metal Industries. Primary metal manufacturing processes other than steel making may also be sources of significant waste loads. However, the quantity of these wastes produced in the Study Area are of much less importance than those produced in the steel mills both because of the size of the establishments and because of lower water demans in these industries. Although plants located in the Study Area are engaged in all phases of metal smelting, working, and fabricating for both ferrous and non-ferrous materials, the greatest production is in the manufacture of foundry products, castings, and forgings.

Major water use in these industries is for cooling. The contaminant level of this water is generally low, but may include oil and suspended materials depending on the exact nature of the process. The principal pollution load arising from foundry operations includes solids contained in wash waters from air pollution systems and contaminants introduced in mold cleaning operations. Air pollution equipment commonly used in these industries includes cyclone separators, wet scrubbers, and fabric arresters. Sources of dust within plants include metallic oxides and smoke from smelting furnaces, foundry shake-out and return sand handling systems, cast cleaning equipment

and abrasive blasting operations. In the molding process phenols present in bonding agents and cleaning materials may become waterborne. Contaminant loads are significantly reduced in foundries using dry sand reclaim operations and gas scrubbers capable of using recirculated water.

The production of rolled, extruded, and drawn metal products results in the discharge of wastes which are more difficult to handle. Most of these processes require the removal of oxide layers and stains in pickle and bright dip solutions containing high concentrations of acids and chromium. While the waste portion of these solutions may be trucked away, rinse solutions are generally discharged to the sewer.

Lead smelting, SIC 3332, is accomplished primarily in open hearth furnaces or in a two-step process which includes sintering followed by smelting in a blast furnace. No water is used directly in these processes. Consequently wastewater problems in the industry are not serious even considering the toxicity of lead.

Two processes are generally used for the production of aluminum. In the Bayer process alumina is solubilized in a NaOH solution leaving impurities which deposit as a mud slurry. The electrolytic smelting of aluminum involves the electrolysis of aluminum from a bath of aluminum and fluoride salts. The off-gas from the smelter which is the most significant waste source contains 0.1-0.2 percent F. The fluoride, present primarily as HF, becomes waterborne after treatment

in wet scrubbers. However, recovery of fluoride is widely practiced and prevents most fluoride produced from being discharged. In the production of aluminum castings, chlorine gas is frequently used to degas castings. The off-gas is frequently scrubbed into NaOH to prevent release of chlorine. Sodium thiosulfate is usually added to the scrubber water to reduce the hypochlorite to chloride which is then discharged.

The principal wastes originating from other primary metal producers are suspended solids, oils, and soluble metals. These wastes are produced primarily in secondary smelting, rolling, and casing operations. Additional pollution may result from cleaning and pickling processes and from heat treating processes utilizing molten salt solutions for holding baths. None of these processes is widely used in this classification.

Wastewaters Produced

Steel Mills. Because of the large quantities of water used within steel mills, wastes produced from the mills in Cleveland have been discussed in many previous reports concerned with the Study Area. Estimated waste loadings were calculated using data contained in these reports in conjunction with industry-wide averages reported for steel mill wastes.

The general procedure used in identifying wastes produced by the steel industry was first to reconcile waste flows reported

previously, then to estimate constituent concentrations and loads based on these flows, production and capacity figures, and industry-wide averages.

Where reported flows represented combined discharges from more than one processing area, estimates were made to separate these flows into the components originating from each process. Values used from Corps of Engineers discharge permit applications were the difference between concentrations in the discharged waste and the intake water. While the validity of this assumption may be challenged, it is the most reasonable approach which could be taken in this study. Removals attained in the treatment processes reported in the EPA industry profile study of the steel industry [23] were used to estimate raw waste loads from concentrations given at the outfall.

Concentrations and loadings estimated for heavy metals and inorganic anions in several instances were estimated from very little historical data. Few values for these constituents are available from literature. Mention of these substances has usually not been made in industry-wide waste production averages both because of the difficulty in obtaining data and because of the small concentrations of these ions present. In addition the amount of various metals present in steel furnace and rolling mill wastewaters will depend largely on alloying substances in the steel being processed. However, because of recent concern over the discharge of heavy metals and because of the consideration of "no-discharge" standards considered

in this report, estimation of several of these substances was included in this inventory.

Other Primary Metal Industries. Other primary metal producers in the Study Area are predominately located in Cleveland. Therefore, data contained in the Dalton-Dalton study [7] was used as the basis for estimating waste loads originating in these industries. Differences in reported waste loads and those expected from a particular industrial category were further investigaged. Suspended solids loads from casting operations reported in the Dalton-Dalton report seemed considerably less than would be expected from sand reclamation operations. However, contacts with several of these firms revealed that dry processes are predominately used for sand reclamation in the Study Area. In most cases the only water used in sand casting processes is for sand cooling after shakeout of the molds. This water is lost through evaporation.

Waste loads applied to the primary metal industries are shown in Table D-XV. As indicated in this table wastes for some categories varied widely in both composition and concentration according to processes used in different firms. In applying these waste loads to firms outside Cleveland, the particular processes used in these firms were determined where possible.

SIC 34, 35, 36, 37 - FABRICATED METAL PRODUCTS, MACHINERY, AND TRANSPORTATION EQUIPMENT

Metal Products Industries in the Study Area

The diversity of activity in the metal products industry is indicated

TABLE D-XV

ESTIMATED WASTE LOADS FOR PRIMARY METAL INDUSTRIES

							Concentration (mg/l)									
SIC	Description	BOD	COD	S.S.	TDS	Acidity	Oil	Fe	Cu	Cr	Cd	Ni	Zn	Pb	F	Al
3312	Steel Mills[a]	15	46	557	16	9	26	101	0.03	-	0.01	-	0.5	0.1	0.2	
3315	Steel Wire Drawing			256	3000	1000	35	289								
3316	Cold Rolled Steel Sheet			500	1000		95	0.3	0.1	0.1	0.04	0.1	0.2			
3317	Steel Pipe															
3321	Grav Iron Foundries	16	73	2024			26	1.0					1.5			
3322	Malleable Iron Foundries[b]			16			110	0.6	0.1	0.2	0.02	0.1	1.3			
3323	Steel Foundries															
3332	Smelting of Lead															
3334	Primary Prod. of Al	200	1000												3.4	0.2
3339	Other Non-ferrous smelting of metals															
3341	Secondary Smelt non-ferrous			300	1000		105	0.3	1.3	0.2	0.04	0.1	0.2			
3351	Rolling of Cooper			12			8	0.4	1.0	0.2		0.1				
3356	Rolling of Non-ferrous Metals															
3357	Drawing of Non-ferrous Wire															
3361	Aluminum Castings			58	3000		78	1.2	0.6	0.2		0.1	0.34			
3362	Brass, Bronze, Cooper Castings			172				2.1	1.4	0.2		0.1				
3369	Non-ferrous Castings															
3391	Iron & Steel Forgings			10			1					0.2				
3399	Primary Metal Products			100			187	6.1	0.1	0.7	0.2	0.1	0.4			

[a] Concentrations calculated from total waste flow including cooling water.

[b] Plants with heat treating processes had 22,700 mg/l T.D.S., 42.1 mg/l TKN, and 4.5 mg/l P in addition to other contaminants.

by the wide variety of metal products used by the average person. The manufacture of electrical appliances, jewelry, automobiles, and a myrid of small metal products used in the home as well as heavier industrial products are classed in the metal products classifications. Because groupings in the Standard Industrial Classification series are made according to the products manufactured in each industry rather than by processes employed, these industries have been grouped together for inclusion in this study. Thus, while the manufacturing processes used in different parts of the industry are similar, these processes are generally employed by firms grouped in many different classifications within SIC categories 34 - 37. The wastes produced by these industries tend to be similar in that constituents present usually include inorganic suspended solids, oils, and dissolved inorganic solids including heavy metals. Organic solids and BOD are usually not important except in cases where organic cleaners and paints are used. However, the accurate identification and evaluation of waste loads produced by the entire industry is a formidable task. For instance, although wastes from plating operations may be estimated for most processes, waste loads may vary significantly if special solutions are used for unusual applications. While variations in wastewater composition were included where information was readily available, it was not possible to extensively search for all such cases.

Metal Products Industries in the Study Area

According to the 1969 Ohio Directory of Manufacturers, the number of firms engaged in the manufacture of metal products was the greatest

of all manufacturing classifications. The number of these establishments is summarized in Table D-XVI.

TABLE D-XVI

NUMBER OF METAL PRODUCTS INDUSTRIES

SIC	Description	Number of Firms[a]
34	Fabricated Metal Products	847
35	Nonelectrical Machinery	1,202
36	Electrical Machinery	191
37	Transportation Equipment	122
		2,362

[a]Data obtained from the 1969 Ohio Directory of Manufacturers [21].

Total employment for these industries in the Study Area summarized in Table D-XVII equals 202,000 or approximately 51 percent of the total employment in the six county area. From these figures, the average firm employs 85 persons. However, there are many small firms and a few very large ones which deviate greatly from this average. The categories containing the largest number of plants are SIC 359, miscellaneous nonelectrical machinery (330 firms); SIC 3544, tool and die works (260 firms); SIC 3451, screw machine products (150 firms); SIC 3471, electroplating (125 firms); and SIC 3461, metal stamping (112 firms).

TABLE D-XVII

EMPLOYMENT SUMMARY FOR METAL

PRODUCTS INDUSTRIES - SIC 34, 35, 36, 37

		County					
SIC	Description	Cuyahoga	Summit	Lake	Portage	Medina	Geauga
341	Metal Containers	492	-	-	-	-	-
342	Hand Tools, Hardware	3123	782	188	22	6	-
343	Building Products	2348	-	65	-	130	89
344	Fabricating Structural Metal Products	6765	8131	161	86	69	3
345	Industrial Fasteners	9871	163	286	380	-	79
346	Metal Stampings	13111	5505	161	-	-	-
347	Coated Products	2390	281	70	8	7	-
348	Fabricated Wire Prods.	2344	19	1168	-	-	17
349	Misc. Fab. Prods.	2767	745	419	32	100	14
		43211	15625	2518	528	312	202
352	Farm Machinery	236	590	-	24	-	30
353	Construction Machinery	6948	1446	1075	25	6	-
354	Machine Tools	18637	2642	1804	753	8	118
355	Machinery for Industry	4870	3099	111	64	10	118
356	Industrial Equip. (pumps)	4286	569	127	372	3	45
357	Office Mach; Scales	3537	-	61	-	-	-
358	Air Cond., Commercial Laundry Machinery	1427	17	119	-	-	-
359	Misc. Machinery except Electrical	3941	1069	454	378	82	4
		43612	9423	3751	1616	109	315
361	Elec. Distribution Equip.	1081	-	15	105	-	742
362	Elec. Industrial Apparatus	9831	214	229	722	28	42
363	Household Elec. Appliances	1541	42	41	-	163	-
364	Lighting Fixtures	6688	178	-	-	-	-
365	Radio and TV	1323	100	-	-	-	-
366	Message Transmitting Equip.	1218	28	182	-	-	-
367	Electronic Components	1668	27	362	-	-	-
369	Elec. Equip., Batteries	2495		6	-	-	-
		25845	589	835	827	191	784
371	Cars, Trucks, Parts	32079	769	317	52	110	-
372	Aircraft Parts	10298	6978	211	78	-	-
373	Ship & Boat Parts	47	-	151	534	-	-
374	Railroad & Street Cars	16	-	-	-	-	-
375	Motorcycles, Bicycles	5	-	-	-	-	-
379	Trailers & Misc.	39	64	19	4	-	-
		42484	7811	698	668	110	-

Approximately 30 firms in the area employ greater than 1,000 persons. Eleven of these firms are engaged in the manufacture of transportation equipment (SIC 37) and eight are producers of fabricated metal products (SIC 34).

The SIC 34 classification includes the fabrication of both ferrous and nonferrous metal products. Subcategories include the manufacture of metal cans, hand tools, hardware, fabricated structural products, fasteners, metal stamping, coated products, and fabricated wire products. Some important segments of the metal fabricating industries are classified in separate groups, such as nonelectrical machinery, SIC 35; electrical machinery, equipment, and supplies, SIC 36; and transportation equipment, SIC 37.

The number and combination of these processes employed in any industrial subcategory will vary depending on the particular products produced in a specific plant. Further, different processes may be used to manufacture identical products depending on the raw materials purchased. For instance, one manufacturer of machine parts may purchase component parts which have been previously plated while another firm may buy stampings which are plated in the fabricating plant. Both companies might be grouped in the same SIC subcategory.

Sources of Waste in Manufacturing Processes

Metal fabrication encompasses a wide scope of operations and treatments of ferrous and nonferrous metals which affect the size, shape, and configuration of the material as well as surface preparations and finishes. A particular plant may generate a single contaminant

or a combination of contaminants depending on the processes utilized in the plant. Basic processes found in such plants involve metal removal (machining), forming (stamping), joining (welding, brazing, and soldering), and finishing (cleaning, plating, and painting). Waste loads will further be described by discussing metal working and fabrication processes and plating operations. In addition, the manufacture of motor vehicles will be discussed because of the significance of this industry in the Study Area.

Metal Working and Fabrication. Machining of metals usually involves the use of coolants, cutting oils, and lubricants. Lubricating oils can be reused within the plant by separating the oil from metal fines. Coolants also can be recycled if proper care is taken to prevent putrification. Cast iron machining produces dust particles which is sometimes scrubbed from exhaust gases using wet scrubbers.

Surface finishing processes such as production grinding, scratch brushing, and abrasive cutoff operations result in the production of some airborne particles which are usually removed by wet scrubbers. Buffing wheels are frequently the source of lint particles discharged to the air. The exhaust gases from this process is usually treated in wet scrubbers or cyclone collectors.

Heat treating of metals to produce certain desired physical properties of metals involves heating, holding at a specific temperature, and cooling. The sources of waste in this process include spillage and carryover of molten salts and oils used as holding baths and

cooling solutions. Vapors which are produced in holding and cooling operations and those resulting from heating furnaces, usually do not become waterborne.

Joining processes including welding, brazing, and soldering produce no significant wastewaters. Contaminants such as metal fume, ozone, fluoride gases, and other gases do not routinely enter wastewaters.

Cleaning, Plating, and Painting. Cleaning and conversion coating processes utilize a diverse group of materials which may include highly acidic or caustic materials, phosphates, and toxic substances including chlorinated hydrocarbon and cyanide cleaning agents. Some of these compounds will be contained in wastewater if spills are not contained and if water rinses are employed. Surface coatings may be applied in a variety of ways including dipping, spraying, and electrostatic painting. The primary source of wastewater is from water spray curtains used to collect emissions from spray booths. This water may be recirculated following removal of paint and solvents.

Wastes in plating operations arise from cleaning to remove surface oils, pickling to remove rust and scale, and electrochemical or chemical processing to apply a coating to the metal. Primary contaminants include alkaline cleaners, grease, oil, acids, cyanide, and metals such as chromium, zinc, copper, and tin. Wastes are generally contained in concentrated batch solutions or in rinse water

which are usually operated as continuous flow processes. Concentrated process solutions which are usually discarded on a batch basis include acid pickling solutions, metal and cyanide plating solutions, and alkali cleaning solutions. Rinse waters will contain the same compounds, but areusually generated on a continuous basis. Contaminant loads will vary according to in-plant procedures concerning the amount of dragout carried over to rinse tanks, the quantity of rinse water used,and the amount of admixture with other process streams. Ranges and average values for combined chromium and cyanide plating rinses are shown in Table D-XVIII.

Concentrated spent pickle liquors, alkaline cleaning solutions, and bright dip wastes are usually disposed of by lagooning, deep well injection, or by chemical treatment at the industry. While the volume of these wastes is usually small, the contaminant loads are most significant and must be dealt with properly.

Motor Vehicle Assembly. Vehicle production operations can be classified as parts production, body assembly, and final assembly. Processes used by manufacturers of buses and trucks are similar to those employed for automobile manufacture.

Major body parts are produced by stamping which includes cutting, stamping, and some welding. From the stamping operation parts are sent to fabricating shops, then treated and painted. The completed body goes to the assembly plant where the chassis, wheels, and power train are assembled and connected to the body.

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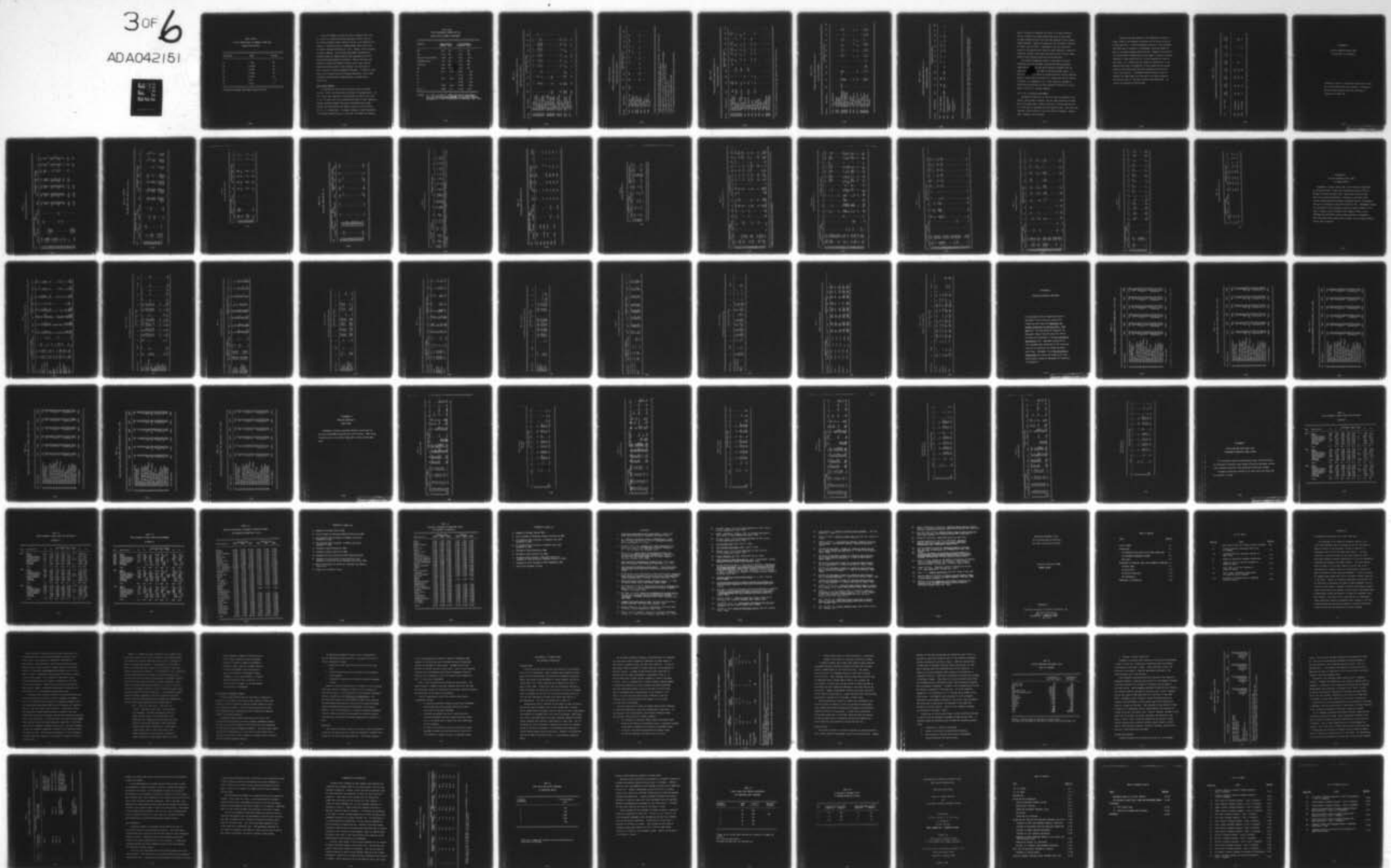

TABLE D-XVIII

TYPICAL COMPOSITIONS FOR COMBINED CHROME AND CYANIDE RINSE WATERS[a]

Constituent	Range	Average
Cr	2-76	40
CN	0.2-204	39
Cu	0.5-88	39
Ni	0.1-205	30
Zn	0.2-68	20
Cd	0.5-4	1.2
Fe	1.5-31	2

[a] Values are averages from several sources [31,51].

Only small amounts of water are used in stamping plants and, as a result, no significant wastes originate in these processes. Oil, which originates from a variety of points in the manufacturing process, is usually present in concentrations ranging from fifty to several thousand milligrams per liter. However, these substances are easily removed. The principal constituents originating in assembly plants are organic materials and suspended solids from painting and body preparation processes. Most of the waste load produced in painting originates from the use of water curtains around paint booths used to trap overspray. This water may be easily reused to minimize wastewater discharges. In addition, heavy metals may originate from metal treating operations. Waste loads produced in body and final assembly plants are summarized in Table D-XIX.

Waste Loads Produced

As indicated in Table D-XVII, the great majority of metal products firms in the Study Area are located in Cuyahoga County. For this reason, data reported in the Dalton-Dalton study [7] was used as the principal basis for assigning waste loads to these industries. Average wastewater compositions used in estimating waste loads outside the Cleveland Area are shown in Tables D-XX to D-XXII for SIC 34 - 37, respectively. In several instances, large fluctuations in wastewater composition for a particular four-digit SIC category

TABLE D-XIX

TYPICAL WASTEWATER COMPOSITION FOR

MOTOR VEHICLE ASSEMBLY OPERATIONS[a]

Parameter	Body Assembly		Final Assembly	
	lb/body	mg/l	lb/vehicle	mg/l
BOD	2.07	194	1.15	188
COD	6.18	580	3.90	639
Solvent Soluble Material	0.385	36.1	0.50	81.8
Suspended Solids	1.76	165	1.84	300
Alkalinity	0.98	920	2.19	358
TDS	0.65	61.0	2.00	327
Fe	0.04	3.75	0.02	3.27
Zn	-	-	0.011	1.80
Al	0.01	0.94	0.026	4.25
Pb	-	-	0.002	0.33
Cr	0.042	3.90	0.042	6.90
Total P	0.065	6.1	0.162	26.5

[a] SOURCE: U. S. Dept. of Interior, FWPCA, The Cost of Clean Water, Vol. III, Industrial Waste Profiles No. 2, Motor Vehicles and Parts, U. S. Govt. Printing Office, Washington, (Nov. 1967).

TABLE D-XX

AVERAGE WASTEWATER COMPOSITION FOR SIC 34 -

FABRICATED METAL PRODUCTS

SIC No.	Description	TDS	SS	Oil	CN	Ni	Cu	Cr	Zn	Cd	Fe	Pb
				Concentration (mg/l)								
3411	Metal Cans	-	2	1	-	0.1	0.1	0.2	0.11	-	0.1	-
3423	Hand & Edge Tools	-	-	-	-	-	-	-	-	-	-	-
3425	Hand Saws & Blades	-	-	-	-	-	-	-	-	-	-	-
3429	Hardware, n.e.c.	-	32	15	-	0.1	0.1	0.2	0.08	0.04	-	0.2
3431	Enameled Iron	-	44	-	-	0.1	0.1	0.2	0.12	0.05	0.6	-
3432	Plumbing Fixtures	-	40	72	2.0	6.4	3.0	3.0	0.10	0.04	1.4	-
3433	Nonelect. Heating Equipment	-	-	-	-	-	-	-	-	-	-	-
3441	Fab. Struct. Steel	-	-	-	-	-	-	-	-	-	-	-
3442	Metal Doors & Trim	-	-	-	-	-	-	-	-	-	-	-
3443	Fab. Plate Works	-	-	-	-	-	-	-	-	-	-	-
3444	Sheet Metal Work	4000	60	300	-	-	-	-	-	-	-	-
3446	Ornamental Metals Work	-	-	-	-	-	-	-	-	-	-	-
3449	Misc. Metal Work	-	-	-	-	-	-	-	-	-	-	-
3451	Screw Machine Prod.	-	-	-	-	-	-	-	-	-	-	-
3452	Bolts, Nuts, Screws[a]	750	820	5	-	0.4	0.5	0.5	0.2	0.08	234	
3461	Metal Stampings[b]	4,000	300	600	5.4	0.3	2	5	0.5	0.2	0.7	
3471	Electroplating & Coloring[c]	350	200	18	40	30	40	50	20	1.2	3.0	-
3479	Coating, Engraving n.e.c.[d]	1,100	50	29	8	8	8	28.2	8	0.3	2.7	-

TABLE D-XX (cont'd)

AVERAGE WASTEWATER COMPOSITION FOR SIC 34 -

FABRICATED METAL PRODUCTS

SIC No.	Description	TDS	SS	Oil	Concentration (mg/l) CN	Ni	Cu	Cr	Zn	Cd	Fe	Pb
3481	Misc. Fab. Wire Products	4,000	196	300	-	0.3	0.2	0.25	0.6	0.34	0.7	-
3491	Metal Shipping Barrels[e]	-	-	-	-	-	-	2.5	7.1	-	-	-
3493	Steel Springs	-	-	-	-	-	-	-	-	-	-	-
3494	Fab. Pipe & Fittings[f]	-	48	216	40	30	40	50	20	1.2	2.1	-
3497	Metal Foil & Lead	-	-	-	-	-	-	-	-	-	-	-
3498	Fab. Pipe & Fittings	-	-	-	-	-	-	-	-	-	-	-
3499	Fab. Metal Prod., n.e.c.	-	-	-	-	--	-	-	-	-	-	-

[a] One firm had alkalinity of 27,800 mg/l as $CaCO_3$, S.S. of 4,000 mg/l, and oil of 5672 mg/l. Only 10 percent of all firms had contaminated discharge.

[b] Only approximately 5 percent of all firms had contaminated discharges.

[c] Discharges also contained 2600 mg/l alkalinity as $CaCO_3$

[d] Discharges also contained 5 mg/l Ag.

[e] Only one firm had a contaminated discharge.

[f] All of contaminated discharge from two firms which do electroplating.

TABLE D-XXI

AVERAGE WASTEWATER COMPOSITION FOR SIC 35 -

NONELECTRICAL MACHINERY

SIC No.	Description	TDS	SS	Oil	Alk	Concentration (mg/l) CN	Ni	Cu	Cr	Zn	Cd	Fe	Pb
3522	Farm Machinery	-	10	-	-	-	0.1	0.1	0.2	0.1	-	0.4	-
3531	Const. Machinery[a]	620	384	2	-	97	0.2	0.9	0.4	1.26	-	4.5	-
3532	Mining Machinery	-	-	-	-	-	-	-	-	-	-	-	-
3534	Elevators	10,600	500	-	1,300	-	30	40	40	20	1.2	2	
3535	Conveyors	-	-	-	-	-	-	-	-	-	-	-	-
3536	Hoists & Cranes	-	-	-	-	-	-	-	-	-	-	-	-
3537	Industrial Trucks Trailers	14,750	1,110	-	4,600		1.4	24	20	20	-	150	-
3541	Cutting Machine Tools	-	24	36	-	2	0.1	0.7	12.8	0.5	0.1	5.0	
3542	Forming Machine Tools	10,500	535	-	1,300	-	-	-	-	-	-	-	-
3544	Special Dies & Tools	-	6	2	-	-	0.1	0.1	0.2	0.5	0.6		
3545	Machine Tool Accessories	1,200	137	115	-	-	0.4	0.3	0.2	0.3	-	0.2	-
3548	Metal Working Machinery	-	-	-	-	-	-	-	-	-	-	-	-
3551	Food Prod. Machinery	-	-	-	-	-	-	-	-	-	-	-	-
3552	Textile Machinery	-	-	-	-	-	-	-	-	-	-	-	-
3554	Paper Machinery	-	-	-	-	-	-	-	-	-	-	-	-
3555	Printing Equipment	-	-	-	-	-	-	-	-	-	-	-	-

[a] Only firm with contaminated discharge had cyanide salt heat treating process.

TABLE D-XXII

AVERAGE WASTEWATER COMPOSITION FOR SIC 36 -

ELECTRICAL MACHINERY

		Concentration (mg/l)											
SIC No.	Description	TDS	SS	Oil	Alk	CN	Ni	Cu	Cr	Zn	Cd	Fe	Pb
3611	Elect. Measuring Inst.	-	-	-	-	-	-	-	-	-	-	-	-
3612	Transformers	-	-	-	-	-	-	-	-	-	-	-	-
3613	Switchboard Apparatus	-	-	-	-	-	-	-	-	-	-	-	-
3621	Motors & Generators	22,000	200	1,760	-	-	0.2	1.0	20	1.2		6.0	-
3622	Industrial Controls	-	46	25	-	-	0.1	0.3	15	0.9	0.1	2.0	-
3623	Welding Apparatus	-	180	-	-	-	-	-	-	-	-	-	-
3624	Carbon & Graphite Prod.	-	-	-	-	-	-	-	-	-	-	-	-
3629	Elect. Indust. Apparatus	-	-	-	-	-	-	-	-	-	-	-	-
3634	Elec. Housewares & Fans	-	28	-	-	-	4	0.1	0.2	1.5	-	0.1	-
3635	Household Vacuum Cleaners	-	103	25	-	-	10	0.1	33	10	-	2	-
3639	Appliances, n.e.c.	-	-	-	-	-	-	-	-	-	-	-	-
3641	Elect. Lamps	-	-	-	-	-	-	-	-	-	-	-	-
3642	Lighting Fixtures	-	100	16	-	-	0.1	2.0	0.2	1.0	2.0	9.0	-
3643	Elect. Wiring	-	95	6	7300	0.7	0.1	0.2	0.2	-	0.3	0.2	-
3644	Noncurrent Wire Devices	-	83	4	-	-	0.1	0.2	0.2	-	0.2	0.3	-

TABLE D-XXIII

AVERAGE WASTEWATER COMPOSITON FOR SIC 37 -

TRANSPORTATION EQUIPMENT

		Concentration (mg/l)												
SIC No.	Description	TDS	SS	Oil	Alk	P	Ni	Cu	Cr	Zn	Cd	Fe	Al	Mn
3713	Truck & Bus Bodies		82	500			0.1	0.7	0.2	0.3	2	6		
3714	Motor Vehicle Parts	2000	2000	300	2700	25	5	6	6.8	3.4	0.3	24.1	2	2
3722	Aircraft Engines [a] & Parts													
3729	Aircraft Parts, n.e.c. [a]													

[a] No contaminated waste discharges for these industries were reported in the Cleveland industrial waste survey. Data from other plants were taken from Corps of Engineers permit applications.

made it necessary to determine the nature of in-house processes used in a certain firm before waste loads could be calculated. In other categories only a few firms were reported to have contaminated discharges. Mention of these cases was included as footnotes in Tables D-XX to D-XXIII. Subsequently, this was taken into account in calculating waste loads for other industries. Industrial categories located in the Study Area which are not listed in these tables do not discharge significant waste quantities.

The primary contaminant present in the wastes from these industries resulted from metal cleaning and plating processes. Industries which do not have these processes frequently did not report contaminated water usage in the Dalton-Dalton report. In many SIC categories in which no contaminated water use was reported, water is used primarily for make-up in quench tanks and for cooling of welders, air compressors, etc. Other industries engaged in fabrication of machinery and other equipment frequently do not use waster in excess of sanitary demands.

SIC 72, 75 - CLEANING ESTABLISHMENTS

Although the industries in the SIC 72 and 75 categories do not employ a great number of people, they use large quantities of water. Much of the water used in these industries is recirculated and thus it is difficult to determine the exact quantity used. There are three important classifications in this two digit SIC category: laundromats, laundries, and car washes.

There are over 200 laundries, 150 laundromats, and 150 car washes listed in the telephone directories of the various districts in the Study Area. In the Dalton-Dalton study [7], it was estimated that there were 25 laundries, 8 laundromats, and 20 car washes in each of the three Clevland sewer districts. Because of the difficulties encountered in determining the exact number of each of the above industries in each sewer district, a similar approach was taken in this study. After subtracting the industries accounted for in the Dalton-Dalton study, the remainder of these industries were proportioned to the various sewer districts according to the relative size of each district. A telephone survey was made in order to determine the approximate flow from each of the three categories and then the loads to the sewer districts were determined. The results are presented in Table D-XXIV.

TABLE D-XXIV

WASTEWATER CHARACTERISTICS FOR THE CLEANING ESTABLISHMENTS

SIC	Description	BOD (mg/l)	COD (mg/l)	TDS (mg/l)	SS (mg/l)	Oil (mg/l)	N (mg/l)	P (mg/l)	Alk (mg/l)
7211	Laundromats	100	450	1,300	200	-	-	-	-
7215	Laundries	276	557	760	393	28	12	6	486
7542	Car Washes	37	212	341	86	-	5	16	76

ATTACHMENT E

EXISTING INDUSTRIAL WASTE LOADS

BY TWO-DIGIT SIC CATEGORIES

Attachment E contains a summarized existing waste loads for the Study Area before any treatment. Discharges to municipal sewer systems and direct discharges to waterways are identified.

TABLE E-I

1970 RAW WASTE LOADS FOR SIC 20

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	TDS	Oil	N	P
2011	0.654	-	-	-	4197	6877	2289	2728	1144	381	107
2011	-	-	0.017	-	13	23	15	-	-	5	1
2013	0.426	-	-	-	3198	6040	2238	2540	1066	355	89
2015	0.089	-	-	-	816	1336	482	668	54	171	19
2022	0.0091	0.0238	-	-	145	182	15	144	-	7.6	1.9
2024	-	0.028	-	-	-	-	-	-	-	-	-
2026	1.54	1.466	-	-	24403	20875	2569	18623	-	771	180
2031	0.129	-	-	-	1130	2259	645	3765	323	430	538
2033	0.013	-	-	-	170	298	88	428	3	16	4.3
2035	0.046	-	-	-	923	1231.	269	1515	11	58	15.3
2035	-	-	1.74	0.21	34828	46437	10158	57321	435	2177	580
2036	0.08	-	-	-	667	401	467	2435	33	254	367
2036	-	-	0.02	-	34	350	110		1	1	1
2037	0.226	-	-	-	2827	5278	1319	7539	-	18	94
2041	-	-	-	-	-	-	-	-	-	-	-
2042	- -	-	-	-	-	-	-	-	-	-	-
2051	0.7	-	-	-	56045	186816	36779	65969	175	409	1168
2071	-	0.0176	-	-	-	-	-	-	-	-	-
2072	-	0.0007	-	-	-	-	-	-	-	-	-
2082	2.392	0.033	-	-	31919	58850	15361	-	-	1277	319

TABLE E-I (cont'd)

1970 RAW WASTE LOADS FOR SIC 20 (cont'd)

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	TDS	Oil	N	P
2084	-	-	-	-	-	-	-	-	-	-	-
2085	-	0.005	-	-	-	-	-	-	-	-	-
2086	1.08	-	-	-	4504	16212	900	28823	-	27	36
2086	-	-	0.025	-	104	375	21	-	-	0.9	1.2
2093	0.004	-	-	0.399	211	422	51	-	-	5	0.8
2094	0.109	-	-	-	1364	11676	909	454	273	136	3
2094	-	-	0.089	-	1400	2746	946	-	2	218	5
2095	-	-	-	-	-	-	-	-	-	-	-
2097	0.142	-	-	-	142	462	261	-	4	-	-
2099	0.666	-	-	-	6665	21662	11887	8443	161	500	83
Totals	8.305	1.574	-	-	139326	340877	76544	144074	3247	4816	3025
			1.89	0.609	36379	49931	76529	57321	438	2402	588

TABLE E-II

1970 RAW WASTE LOADS FOR SIC 22

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	TDS	Oil	N	P
2231	0.008	0.001	-	-	31	122	12	100	-	1	1
2253	0.032	0.024	-	-	120	480	45	400	-	6.1	4.5
2261	-	0.049	-	-	-	-	-	-	-	-	-
2269	0.525	-	-	-	1970	7881	744	8757	-	6	31
2271	-	-	-	-	-	-	-	-	-	-	-
2279	-	-	-	-	-	-	-	-	-	-	-
2281	-	-	-	-	-	-	-	-	-	-	-
2283	0.0044	-	-	-	17	66	6	55	-	1	1
2294	0.0316	-	-	-	134	553	137	395	-	2.4	2.4
2295	-	-	-	-	-	-	-	-	-	-	-
2296	-	-	-	-	-	-	-	-	-	-	-
2298	-	-	-	-	-	-	-	-	-	-	-
Totals	0.601	0.074	-	-	2272	9102	944	9707	-	16.5	40

TABLE E-III

1970 WASTE LOADS FOR SIC 26

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	N	SO_4
2621	-	-	1.8	0.14	500	2000	1250	38	2180
2631	-	0.038	-	-	-	-	-	-	-
2641	0.014	0.003	-	-	0.2	0.5	1.4	-	-
2642	-	0.0272	-	-	-	-	-	-	-
2643	-	0.0028	-	-	-	-	-	-	-
2644	-	0.007	-	-	-	-	-	-	-
2645	-	0.023	-	-	-	-	-	-	-
2647	-	0.0048	-	-	-	-	-	-	-
2649	-	0.0045	-	-	-	-	-	-	-
2651	-	0.0379	-	-	-	-	-	-	-
2652	-	0.0063	-	-	-	-	-	-	-
2653	-	0.229	-	-	-	-	-	-	-
2655	-	0.096	-	-	-	-	-	-	-
Totals	0.014	0.4795	-	-	0.2	-	1.4	-	-
			1.8	0.14	500	2000	1250	38	2180

TABLE E-IV

1970 WASTE LOADS FOR SIC 28

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	BOD	COD	SS	TDS	CONTAMINANT LOADS (lb/day) Oil	N	Cu	Cr	Ni	Zn	Fe
281 [a]	-	-	2.395	5.205	-	2963	20655	27117	31	1849	2.2	27.7	5.9	1912	24.7
2822	0.218	0.162	0.03	-	620	-	455	11330	43	3.1	-	-	-	-	-
2851	1.003	0.061	-	0.2584	2447	5985	874	3486	298	-	1.03	2.1	1.03	2.67	9.05
Totals	1.22	0.223	-	-	3067	5985	1329	14816	341	3.1	1.03	2.1	1.03	2.7	9.05
	-	-	2.425	5.463	-	2963	20655	27117	31	1849	2.2	27.7	5.9	1912	24.7

[a] *Discharges from this industry also contained the following contaminants in addition to those above:*
P - 5.8 lb/day, F - 213 lb/day, Cl - 2816 lb/day, Cd - 4.1 lb/day, Pb - 1.5 lb/day, Al - 44 lb/day, Ba - 3 lb/day, B - 8.15 lb/day, Ti - 31.4 lb/day, Co - 4.9 lb/day.

TABLE E-V

1970 RAW WASTE LOADS FOR SIC 29

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	TDS	Oil	P	Phenol
2911	0.025	-	-	-	94	577	144	2055	202	-	-
2951	-	0.663	-	-	-	-	-	-	-	-	-
2952	0.0333	0.337		-	11	31	-	-	1.4	-	0.3
2992	0.187	0.053			21	62	142	1938	9	3	0.5
2992	-	-	0.43	0.103	49	141	326	4456	22	7	1.2
Totals	0.245	1.053	-	-	126	670	286	3993	212	3	0.8
			0.43	0.103	49	141	326	4456	22	7	1.2

TABLE E-VI

1970 WASTE LOADS FOR SIC 30

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	TDS	Oil
3011[a]	8.91	-	-	82	15,800	96,200	24,800	186,900	1600
3069	3.17	0.255	-	-	-	-	476	-	-
3069	-	-	8.34	1.165	-	-	1253	-	-
3079	2.09	1.47	-	-	174	-	3050	-	-
3079	-	-	0.056	0.54	5	-	82	-	-
Total	14.17	1.725	-	-	15,974	96,200	28,326	186,900	1600
	-	-	8.4	83.705	5	-	1335	-	-

a Also includes waste loads originating from latex production in tire manufacturing plants.

TABLE E-VII

1970 WASTE LOADS FOR SIC 33

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day)[a] BOD	COD	SS	TDS	Acidity	Oil	F	Cu	Cr	Cd	Ni	Pb	Zn	Fe
3312	3.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3312[a]	-	-	81=	369.1	56700	172070	2086300	58350	35000	96873	778	142.3	272	400	203	312.4	1991	376901
3313	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3315	0.227	-	-	-	-	-	486	5691	350	66	-	-	-	-	-	-	-	948
3316	0.189	-	-	-		--	788	1576	-	150	-	0.17	0.22	0.06	0.2	-	0.29	0.49
3317	-	0.063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3321	0.111	0.111	-	8.24	11	60	1874	-	-	24	-	-	-	-	-	-	1.39	0.93
3322	0.288	0.112	-	0.369	-	-	38	-	-	264	-	0.24	0.48	0.05	0.24	-	3.19	1.44
3323	-	0.524	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3332	-	0.046	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3333	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3334	0.069	-	-	-	115	575	115	-	-	14	2	0.06	0.12	0.06	0.17	-	0.23	0.17
3339	-	0.099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3341	0.392	0.048	-	0.727	-	-	444	11014	-	401	-	0.26	0.04	0.0008	0.0026	21	64	1.0
3351	1.347	-	-	-	-	-	135	-	-	90	-	11.2	2.2	-	1.12	-	-	4.5
3352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3356	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3357	-	0.015	-	-	--	-	-	-	-	-	-	-	-	-	-	-	-	-
3361	0.386	7.4	-	0.026	-	-	187	9658	-	251	-	1.9	0.64	-	0.22	-	1.09	3.9
3362	0.016	0.083	-	-	-	-	119	-	-	-	-	0.97	0.14	-	0.07	-	2.67	1.5
3369	-	0.193	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3391	0.819	0.410	-	-	-	-	68	-	-	6.8	-	-	-	1.4	-	-	-	-
3399	1.836	-	-	-	-	-	1531	1000	-	2863	-	1.7	10.7	3.4	1.3	-	6.3	93.4
Totals	9.51	9.104	-	-	126	635	5785	28939	350	4130	2	16.5	14.54	3.5	-	21.	79.2	1055
	-	-	81	378.5	56700	172070	2086300	58350	35000	96873	778	142.3	272	400	203	312.4	1991	376901

[a] Discharges from this industry also contained the following contaminants in addition to those above: N-8563 lb/day, P-246 lb/day, SO_4-23530 lb/day, Cl-92410 lb/day, CN-408 lb/day, Phenol-455 lb/day, Al-0.086 lb/day.

TABLE E-VIII

1970 WASTE LOADS FOR SIC 34

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) COD	SS	TDS	Alk	Oil	CN	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe
3411	0.092	0.067	-	-	-	1.5	-	-	0.8	-	-	0.8	0.16	0.04	0.08	-	0.08	0.08
3423	0.0086	0.069	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3425	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3429	0.465	0.033	-	-	-	124	-	-	58	-	-	0.39	0.80	0.16	0.39	30.80	0.31	-
3431	0.0282	0.0012	-	-	-	10.3	-	-	-	-	-	0.024	0.047	0.021	0.024	-	0.028	0.14
3432	0.202	0.0462	-	-	-	67	301	-	121	3.36	-	5.05	5.05	0.07	10.78	-	0.17	2.36
3433	-	0.022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3441	-	0.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3442	-	0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3443	-	0.949	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3444	0.603	0.348	-	-	-	314	-	-	227	-	-	-	-	-	-	-	-	-
3446	-	0.071	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3449	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3451	-	0.132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3452	6.09	0.65	-	-	1532	25919	38092	21178	2075	542	-	459	425	1.33	342	1.3	3.3	6765
3461	0.55	3.055	-	-	4	1008	20727	2594	1836	25.3	3.6	6.8	22	2	3.2	-	3.4	4.8
3461	-	-	0.513	-	5	940	19332	2419	1712	23.6	3.4	6.4	20.6	1.8	2.9	-	3.2	4.5
3471	4.07	0.299	-	-	-	207	25984	-	-	1101	-	855	601	47.9	1048	-	917	134.5
3471	-	-	0.976	-	-	50	6231	-	-	143	-	144	273	11.5	288	-	193	8.3
3478	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3479	0.321	0.0041	-	-	-	126	2558	-	74	2.75	12.7	2.95	71.5	0.76	7.4	-	1.04	6.8
3479	-	-	0.018	0.044	-	7	143	-	4	0.15	0.7	0.15	4	0.04	0.4	-	0.06	0.4
3481	0.567	0.299	-	0.062	-	927	15527	-	1419	-	-	0.9	1.2	1.6	1.4	-	2.8	3.3
3491	0.134	0.107	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3493	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3494	0.52	0.0268	-	-	-	533	93	-	727	14	-	1.58	1.43	1.17	1.38	-	1.98	5.1
3497	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3498	-	0.115	0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3499	0.078	0.0021	0.0107	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	13.73	6.47	-	-	1536	28110	103282	23772	6538	1688	17.0	1331	1128	55.1	1415	32/1	930	6922
	-	-	1.517	1.106		997	25706	2419	1716	167	3.4	151	298	13.3	291	-	196	13.2

TABLE E-IX

1970 WASTE LOADS FOR SIC 35

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) SS	TDS	Alk	Oil	CN	Cu	Cr	Cd	Ni	Zn	Fe
3522	0.29	0.0204	-	-	24.2	-	-	-	-	0.24	0.48	0.10	0.24	0.19	0.10
3531	0.0123	-	-	-	39	64	-	0.2	9.9	0.09	0.04	-	0.02	0.13	0.46
3532	-	0.051	-	-	-	-	-	-	-	-	-	-	-	-	-
3534	0.213	0.0057	-	-	887	18803	2306	-	-	71	71	2.1	53.2	35.5	3.5
3535	-	0.018	-	-	-	-	-	-	-	-	-	-	-	-	-
3536	-	0.056	-	-	-	-	-	-	-	-	-	-	-	-	-
3537	0.004	0.222	-	-	35	466	144	-	-	0.76	0.63	0.001	0.04	0.63	4.74
3541	0.60	0.147	-	-	895	26000	385	4113	10	0.5	1.0	0.4	0.5	5.5	36.5
3542	0.468		-	-	2088	40983	5074	-	-	-	-	-	-	-	-
3544	0.011	-.56	-	-	0.6	-	-	0.2	-	0.01	0.02	0.004	0.01	0.04	0.06
3545	0.126	0.546	-	-	144	-	-	121	-	0.26	0.21	0.04	0.4	0.26	1.05
3548	-	0.367	-	-	-	-	-	-	-	-	-	-	-	-	-
3551	-	0.012	-	-	-	-	-	-	-	-	-	-	-	-	-
3552	-	0.053	-	-	-	-	-	-	-	-	-	-	-	-	-
3554	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3555	-	0.277	-	-	-	-	-	-	-	-	-	-	-	-	-
3559	-	0.876	-	-	-	-	-	-	-	-	-	-	-	-	-
3561	-	0.113	-	-	-	-	-	-	-	-	-	-	-	-	-
3564	0.034	0.234	-	-	-	-	-	-	-	-	-	-	-	-	-
3565	-	0.002	-	-	-	-	-	-	-	-	-	-	-	-	-
3566	0.0006	0.065	-	0.015	-	-	-	-	-	-	-	-	-	-	-
3567	-	0.035	-	-	-	-	-	-	-	-	-	-	-	-	-
3569	-	0.046	-	-	-	-	-	-	-	-	-	-	-	-	-
3576	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3579	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-
3582	-		-	-	-	-	-	-	-	-	-	-	-	-	-
3585	-	0.34	-	-	-	-	-	-	-	-	-	-	-	-	-
3589	-	0.036	-	-	-	-	-	-	-	-	-	-	-	-	-
3599	-	0.664	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	1.758	4.746	-	0.015	4113	86316	7909	4234	19.9	73	73	2.65	54.4	42.3	46.4

TABLE E-X

1970 WASTE LOADS FOR SIC 36

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) SS	TDS	Alk	Oil	Cu	Cr	Cd	Ni	Zn	Fe
3611	-	0.143	-	-	-	-	-	-	-	-	-	-	-	-
3612	-	-	-	-	-	-	-	-	-	-	-	-	-	- -
3613	-	0.018	-	-	-	-	-	-	-	-	-	-	-	-
3621	0.044	1.109	-	-	77	8054	2597	498	0.37	7.3	0.015	0.07	0.44	2.27
3622	0.226	0.026	-	-	87	-	-	47	0.57	28.3	0.19	0.19	1.7	3.6
3623	0.089	2.11	0.008	-	145	-	-	-	-	-	-	-	-	-
3624	-	0.022	-	-	-	-	-	-	-	-	-	-	-	-
3629	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3634	0.014	0.617	-	-	3.2	-	-	-	0.01	0.02	-	0.44	0.145	0.01
3635	0.192	0.002	-	-	165	9131	-	40	1.0	35	-	17	17	4
3635	-	-	0.113	-	97	-	-	24	0.9	31.3	-	9.9	10	1.9
3639	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3641	0.554	0.261	-	-	-	-	-	-	-	-	-	-	-	-
3642	0.352	0.418	-	-	293	-	-	47	4.7	0.59	4.7	0.29	3.8	81
3643	0.046	0.009	-	-	37	-	-	2.3	0.06	0.08	0.13	0.04	-	0.1
3644	0.218	- -	-	-	151	-	-	7.3	0.36	0.36	0.44	0.18	-	0.54
3651	-	0.014	-	-	-	-	-	-	-	-	-	-	-	-
3661	-	0.013	-	-	-	-	-	-	-	-	-	-	-	-
3662	-	0.115	-	-	-	-	-	-	-	-	-	-	-	-
3672	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3674	-	0.057	-	-	-	-	-	-	-	-	-	-	-	-
3679	-	0.028	-	-	-	-	-	-	-	-	-	-	-	-
3692	0.059	0.384	-	-	-	-	-	-	-	-	-	-	-	-
3693	-	-	0.061	0.01	-	38	76	5	-	-	-	-	-	-
3694	-	0.0098	-	-	-	-	-	-	-	-	-	-	-	-
3699	-	0.011	-	-	-	-	-	-	-	-	-	-	-	-
Totals	1.79	5.37	-	-	958	17185	2597	642	7.07	71.7	5.5	18.2	23.1	91.5
	-	-	0.18	0.01	97	38	76	29	0.9	31.3	-	9.9	10	1.9

TABLE E-XI

1970 WASTE LOADS FOR SIC 37

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	SS	TDS	Alk	Oil	P	CN	Cu	Cr	Cd	Ni	Zn	Fe	Sn	Al	Mn
3711	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3712	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3713	0.0032	0.0373	-	-	2.2	-	-	13.3	-	-	0.019	0.005	0.043	0.003	0.009	0.15	-	-	-
3714	2.632	4.01	-	-	3300	12055	3281	1319	191	5.7	19	19	1.3	29.3	17.3	20.8	26	25.1	29.2
3714	-	-	1.51	-	1894	6916	1882	757	109	3.3	11	11	0.8	16.8	10	12	15	14.4	16.8
3721	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3722	-	0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3729	-	3.501	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3731	-	0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3732	-	0.0475	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3742	-	0.007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3751	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	2.64	7.67	-	-	3302	12055	3281	1332	191	5.7	19	19	1.3	29.3	17.3	21	26	25.1	29.2
	-	-	1.51	-	1894	6916	1882	757	109	3.3	.11	11	0.8	16.8	10	12	15	14.4	16.8

TABLE E-XII

1970 RAW WASTE LOADS FOR SIC 72, 75

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	CONTAMINANT LOADS (lb/day) BOD	COD	SS	TDS	Alk	Oil	N	P
7211	1.386	-	-	-	1156	4062	2312	15027	-	-	-	-
7215	3.92	-	-	-	10916	24788	13334	23135	17913	852	365	183
7542	3.53	-	-	-	1089	6241	2532	10039	2119	-	147	471
Totals	8.84	-	-	-	13161	35091	18178	48201	20032	852	512	654

ATTACHMENT F

EXISTING INDUSTRIAL WASTE LOADS

BY SEWER DISTRICT

Attachment F contains waste loads in the Study Area summarized by the sewer district in which the discharges originate and by the drainage to which the waste flows. Waste loads given are those which result before pretreatment. Discharges to municipal sewer systems are distinguished from those discharged directly to waterways. The point of discharge is that which existed in 1972. Recommended changes for some wastes to be discharged to municipal sewers discussed in the Phase II report are not included in this summary. Values in this attachment are equivalent to waste loads tabulated in Attachment E. Most constituent totals agree within 5 percent with no values differing by more than 10 percent.

TABLE F-I

1970 RAW WASTE LOADS FOR CUYAHOGA RIVER BASIN

Sewer District	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Oil	TKN	P
Akron	17.98	4.92			39113	57199	35863	237287	5989	2619	521	625.4
			1.70	87.7	19	-	633	-	-	-	-	-
Bedford	0.81	0.229			428	892	799	7098	14.7	576	31.18	4.23
			0.828	0	-	-	761	-	-	123	-	-
Bedford Heights	0.606	0.656	0.001	-	458	1186	594	2100	417	384.6	13	18
Burton	0.057	0.058	-	-	95	86.2	-	1741	-	36.9	0.5	0.9
Cleveland Southerly	12.22	10.825			22719	66121	41102	139734	12141	9294	839	805
	-	-	86.7	378.9	58548	194639	2095384	100410	-	98331	8745	282
Cuyahoga Unsewered	0.107	0.591	-	-	166	554	621	8578	1036	2	1.2	3.5
	-	-	0.361	0.01	1302	5004	676	38	-	5.	-	-
Hudson	0.333	0.031	-	0.14	669	1348	989	1839	1176	85.7	29.1	15
Kent	2.196	0.467	-	-	212	606	5614	13726	559	939.8	18	20.7
	-	-	0.048	-	5	-	85	-	-	-	-	-
Macedonia	0.01	0.003	-	-	6	27	16	78	-	-	-	-
Mantua	0.126	-	-	-	6	104	-	-	-	-	-	-
	-	-	0.071	-	3	59	-	-	-	-	-	-
Middlefield	•0.584	0.40	-	-	277	450	352	179	-	180	25	2.5
	-	-	1.294	0.165	4	-	253	-	-	-	-	-
Portage Unsewered	0.0114	0.0059	0.055	-	106	378	28	3	-	0.03	1.02	1.23
Ravenna	0.574	0.379	-	-	73	256	245	453	-	2	0.64	0.81
	-	-	1.394	-	6	-	274	-	-	-	-	-
Stark Unsewered	0.025	0.001	-	-	243	376	170	171	-	120	21	2.6
Streetsboro	-	0.001	-	-	-	-	-	-	-	-	-	-
Summit Uns.	1.91	1.77	-	-	10134	19031	3234	9099	240	723	318	76
	-	-	1.1	-	1445	7139	263	-	-	-	-	-
Twinsburg	0.288	2.031	0.139	-	681	1402	1440	7998	5078	968	29	15
Totals	37.837	22.007	-	-	75386	250016	91942	430085	26651	15931	1847.6	1590.9
	-	-	93.7	466.95	61332	206841	2098361	100448	-	98459	8746	282

TABLE F-I (cont'd)

1970 RAW WASTE LOADS FOR CUYAHOGA RIVER BASIN

	Contaminant Loads (lb/day)														
Sewer District	CN	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Al	Mn	F	Acidity	SO_4
Akron	461	0.03	0.72	219	65	15.48	200	30	350	1878	0.167	0.124	1.38	-	-
Bedford	143	-	0.62	2.39	69	1.135	4.916	-	55.32	15.14	-	-	-	-	-
	-	-	-	144	180	-	-	-	-	-	-	-	-	-	-
Bedford Hts.	-	-	-	0.306	1.356	0.423	0.117	-	0.369	2.463	-	-	-	-	-
Burton	-	-	-	0.018	0.110	0.036	0.019	-	0.067	0.99	-	-	-	-	-
Cleveland Southerly	23	3	2.1	257.5	258.8	5.02	148	27	198	810	-	-	-	-	-
	639	455	-	423.3	133	403	346	312.4	4332	377629	80	16.8	991	35000	23530
Cuyahoga Uns.	0.08	-	-	0.011	0.013	0.015	0.005	-	0.002	1.61	-	-	-	-	-
Hudson	4.4	-	-	0.04	0.018	-	0.009	-	0.057	0.2	-	-	-	-	-
Kent	92.4	-	-	6.717	10.411	1.129	5.471	-	2.79	66.515	-	-	-	-	-
Macedonia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Middlefield	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Portage Uns.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ravenna	-	-	-	0.005	0.01	0.002	0.005	-	0.074	0.054	-	-	-	-	-
Stark Uns.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Streetsboro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Summit Uns.	3.26	-	2.9	3.4	19.7	0.79	2.08	0.003	1.9	8.1	-	-	-	-	-
Twinsburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	727.14	3.03	6.34	489.4	424.4	24.03	360.62	52	608.53	2783.1	0.167	0.124	1.38	-	-
	639	455	-	567.3	313	403	346	312.4	4332	377629	80	16.8	991	35000	23530

TABLE F-II

1970 RAW WASTE LOADS FOR ROCKY RIVER BASIN

	Wastewater Flow (mgd)				Contaminant Loads (lb/day)							
	City		Stream									
Sewer District	Process	Cooling	Process	Cooling	BOD	COD	SS	TDS	Alk	Oil	TKN	P
Berea	0.235	0.314	0.002	-	14	27	490	539	-	78	-	-
Brook Park	0.0269	0.093	-	-	7	42	25	167	80	15	1	1
Lakewood	0.191	0.037	0.013	-	366	1066	524	1322	310	45	12.7	13.1
Lorain Uns.	0.022	0.012	-	-	-	-	149	139	-	0.99	-	-
Medina	0.297	0.500	-	-	224	863	296	1092	20.8	99.2	13.3	2.84
	-	-	1.74	0.21	34828	46437	19158	57321	-	435	2177	580
Medina Uns.	0.484	-	0.032	-	743	1739	1117	2642	1268	68.1	35	34
Middleburg Hts.	0.053	-	-	-	675	1390	968	1907	1191	68	30	18
North Olmstead	0.127	0.0017	-	-	190	459	387	682	264	17.4	10.9	10.4
Rocky River	0.367	0.13	-	-	264	712	617	3606	771.3	451.3	14.5	18.8
Strongville	0.125	0.006	-	-	222	494	410	663	311	18	14	10.4
Totals	1.928	1.094	-	-	2705	6792	4183	12759	4216	861	131.4	108.5
	-	-	1.787	0.210	34828	46437	10158	57321	-	435	2177	580

TABLE F-II (cont'd)

1970 RAW WASTE LOADS FOR ROCKY RIVER BASIN

	Contaminant Loads (lb/day)											
Sewer District	CN	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Al	Mn
Berea	2.6	-	-	3.109	0.339	0.067	0.231	-	11.291	88.615	-	-
Brook Park	0.134	-	-	0.05	0.05	0.005	0.008	-	0.013	0.017	-	-
Lakewood	-	2.3	0.23	0.28	4.09	0.067	0.39	-	0.11	64.3	-	-
Lorain Uns.	1.3	-	-	0.92	0.09	0.015	0.073	-	0.036	42.4	-	-
Medina	-	-	-	0.001	0.001	-	0.001	0.001	-	-	-	0.004
Middleburg Hts.	-	-	-	-	-	-	-	-	-	-	-	-
North Olmstead	-	-	-	-	-	-	-	-	-	-	-	-
Rocky River	0.53	-	0.6	0.624	5.041	0.202	1.216	-	0.331	3.971	-	-
Strongsville	0.019	-	-	0.004	0.003	0.006	0.006	-	0.017	-	-	-
Totals	4.83	2.3	0.83	4.435	12.279	0.693	2.213	0.001	12.304	20.12	0.003	0.004

TABLE F-III

1970 RAW WASTE LOADS FOR CHAGRIN RIVER BASIN

Sewer District	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Oil	TKN	P
Chagrin Falls	0.153	0.02	-		703	1494	1207	2135	1207	70.4	31	22
	-	-	1.521	0.14	507	22038	1268	-	-	-	-	-
Chardon	0.339	0.011	-	-	89	291	162	198	-	9.96	1.7	1.5
	-	-	0.701	-	3.7	-	164	-	-	-	-	-
Chesterland	0.038	0.127	-	-	570	620	53	435	-	-	18	4.2
Geauga Uns.	0.015	0.015	-	-	86	108	9.8	68	-	-	4.5	1.13
Lake Uns.	0.272	0.261	0.001	-	60	76	468	6087	233	463	3.6	3
Solon	0.493	0.551	-	0.088	4433	14792	3402	8980	469	409	34.1	99
Willoughby	1.325	0.534	-	-	506	1867	2661	3958	1136	316	15.3	25.3
	-	-	1.53	-	-	-	232	-	-	-	-	-
Totals	2.635	1.519	-	-	6447	19348	7963	21861	3045	1268	108.2	156.1
	-	-	3.753	0.228	511	2028	1664	-	-	-	-	-

TABLE F-III (cont'd)

1970 RAW WASTE LOADS FOR CHAGRIN RIVER BASIN

Sewer District	Contaminant Loads (lb/day)												
	CN	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Al	Mn	SN
Chagrin Falls	0.006	-	-	0.02	0.904	0.006	0.006	-	0.054	0.111	-	-	-
Chardon	-	-	-	0.009	0.009	0.081	0.013	-	0.019	0.033	-	-	-
Chesterland	-	-	-	-	-	-	-	-	-	-	-	-	-
Geauga Uns.	-	-	-	0.008	0.016	0.003	0.008	-	0.006	0.003	-	-	-
Lake Uns.	0.22	-	-	0.464	2.345	0.715	0.64	-	1.46	2.12	0.138	0.16	-
Solon	0.68	-	0.9	1.398	7.49	0.464	0.876	-	0.895	1.243	-	-	-
Willoughby	20.5	-	-	2.273	39.866	1.22	3.366	-	1.477	527.13	0.33	0.38	-
Totals	21.41	-	0.9	4.172	50.63	2.489	4.909	-	3.911	530.64	0.468	0.54	-

TABLE F-IV

1970 RAW WASTE LOADS FOR LAKE ERIE AREA

	Wastewater Flow (mgd)				Contaminant Loads (lb/day)							
	City		Stream									
Sewer District	Process	Cooling	Process	Cooling	BOD	COD	SS	TDS	Alk	Oil	TKN	P
Cleveland Easterly	12.05	7.56	-	-	55916	132533	41632	117194	5099	2997	1786	1232
	-	-	0.181	-	166	348	319	6136	299	29	63	91
Cleveland Westerly	6.901	4.052	-	-	2519	80045	30190	60200	11495	3888	1077	527.5
	-	-	2.67	0.672	-	2124	18310	18300	5670	695	24	102
Euclid	1.871	2.632	-	0.057	477	1351	984	3626	183	675	17.14	26.17
Totals	20822	14244	-	-	83912	213929	72806	181020	16777	7260	2880	1785.7
	-	-	2.851	0.729	166	2472	18629	24436	5969	724	90	193

TABLE F-IV (cont'd)

1970 RAW WASTE LOADS FOR LAKE ERIE AREA

	Contaminant Loads (lb/day)													
Sewer District	CN	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Al	Mn	Sn	Acidity	F
Cleveland Easterly	65	5	3.9	254	792	34.2	470	-	88.3	1138	-	-	41	-	-
	16	-	-	0.17	40	9.1	10	-	10	2.5	-	-	-	-	-
Cleveland Westerly	382	2	7.04	140	280	9.02	287	1.5	115	1974	3.9	3.9	-	-	-
	430	-	-	334	417	-	335	1.3	-	5203	-	-	-	-	-
Euclid	4.31	0.13	0.6	8.653	7.186	1.267	0.12	0.076	130.4	-	-	-	-	350	-
Totals	451.3	7.13	11.43	402.65	1079.2	44.49	758.6	1.62	205.4	3242.4	3.9	3.9	41	350	-
	446	-	-	334.2	456	0.1	345	1.3	10	5206	-	-	-	-	-

TABLE F-V

SUMMARY OF 1970 RAW WASTELOADS

Sewer District	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Oil	TKN	P
Lake Erie	20.822	14.24	-	-	83912	213929	72806	181020	16777	7260	2880	1785.7
	-	-	2.851	0.729	166	2472	18629	24436	5969	724	90	193
Chagrin	2.635	1.519			6447	19348	7963	21861	3045	1268	108.2	156.1
	-	-	3.753	0.228	511	2028	1664	-	-	-	-	-
Rocky River	1.928	1.094	-	-	2705	6792	4983	12759	4216	861	131.4	108.5
	-	-	1.787	0.210	34828	46437	10158	57321	-	435	2177	580
Cuyahoga	37.837	22.007	-	-	75386	250016	91942	430085	26651	15931	1847.6	1590.9
	-	-	93.7	466.95	61332	206841	2098361	100448	-	98459	8745	282
Totals	63.222	38.864	-	-	168450	490085	177694	645725	50689	25320	4967	3641.2
	-	-	102.1	468.12	96837	218133	2128812	182205	5969	99618	11012	1055

TABLE F-V (cont'd)

SUMMARY OF 1970 RAW WASTE LOADS

Sewer District	Contaminant Loads (lb/day) CN	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Al	Mn	Sn	Acidity	F
Lake Erie	4513	7.13	11.43	402.65	1079.2	44.49	758.5	1.62	205.4	3242.4	3.9	28.9	41	350	-
	496	-	-	334.2	456	0.1	345	1.3	10	5206	-	-	-	-	-
Chagrin	21.4	-	0.9	4.172	50.63	2.489	4.909	-	3.911	530.64	0.468	0.54	-	-	-
Rocky River	4.38	2.3	0.83	4.435	12.279	0.693	2.213	0.001	12.203	201.2	0.003	0.004	-	-	-
Cuyahoga	727.1	3	6.34	489.4	424.4	24.03	360.62	52	608.58	2783.1	0.167	0.124	-	-	1.38
	639	455	-	567.3	313	403	346	312.4	3645	377629	80	16.8	-	35000	778
Totals	1204.2	12	19.61	900.7	1566.5	71.702	1126.3	53.62	830.1	6757.3	4.7	29.6	41	35350	1.38
	1135	455	-	901.5	769	403.1	691	313.7	4342	382835	80	16.8	-	-	778

ATTACHMENT G

PROJECTED INDUSTRIAL EMPLOYMENT

This attachment contains summarized industrial employment for the Study Area through 2020. Projections were taken from Demographic and Economic Projections for Northeast Ohio: 1970-2020 [52]. For some industrial categories the employment figures from this source for 1970 do not agree with employment in the Ohio Directory of Manufacturers [21]. Employment projections in this attachment were normalized to 1970 values and used only as multipliers for estimating future waste loads. Employment in the Ohio Directory of Manufacturers was used as the authority for estimating present industrial employment for industrial SIC categories.

TABLE G-I

PROJECTED INDUSTRIAL EMPLOYMENT FOR CUYAHOGA COUNTY, 1970 to 2020

SIC	Description	1970	1980	1990	2000	2010	2020
20	Food and Kindred Products	13050	13646	14700	15441	15908	15723
21	Tobacco Manufactures	67	62	58	53	50	46
22	Textile Mill Products	4009	3944	3881	3814	3780	3741
23	Apparel	7124	7007	6894	6774	6712	6641
24	Lumber and Wood Products	957	919	883	848	820	793
25	Furniture and Fixtures	3003	2869	2748	2627	2529	2425
26	Paper and Allied Products	5897	6095	6301	6505	6772	7041
27	Printing and Publishing	16661	17316	18504	19403	20072	20079
28	Chemical and Allied Products	17015	17411	17823	18220	18782	19335
29	Petroleum Refining	3865	3913	3973	4024	4102	4163
30	Rubber and Plastic Products	5858	5942	6092	6110	6244	6371
31	Leather Products	200	213	207	201	197	192
32	Stone, Clay and Glass	4221	4414	4701	4942	5164	5280
33	Primary Metals	34285	32926	31631	30345	29357	28361
34	Fabricated Metals	28056	27650	27342	26974	26786	26477
35	Nonelectrical Machinery	38285	38594	38919	39192	39801	40361
36	Electrical Machinery	24592	24447	24312	24143	24179	24181
37	Transportation Equipment	49835	48225	46681	45125	43989	42821
38	Professional Equipment	3638	3581	3527	3468	3439	3405
39	Miscellaneous Products	3640	3790	4039	4218	4341	4319
	Total Employment	264277	263964	263153	262427	263024	261755

TABLE G-II

PROJECTED INDUSTRIAL EMPLOYMENT FOR SUMMIT COUNTY, 1970 to 2020

SIC	Description	1970	1980	1990	2000	2010	2020
20	Food and Kindred Products	2857	2889	2954	3004	3016	2999
21	Tobacco Manufactures	3	3	3	2	2	2
22	Textile Mill Products	133	130	128	126	124	124
23	Apparel	206	201	197	194	191	191
24	Lumber and Wood Products	295	281	270	259	250	243
25	Furniture and Fixtures	363	343	326	310	296	286
26	Paper and Allied Products	333	342	353	364	378	396
27	Printing and Publishing	2988	3219	3509	3753	3918	3988
28	Chemical and Allied Products	3095	3145	3212	3288	3375	3504
29	Petroleum Refining	178	178	180	182	184	189
30	Rubber and Plastic Products	42201	42519	43041	43680	44438	45740
31	Leather Products	83	80	78	76	74	73
32	Stone, Clay and Glass	2230	2327	2464	2592	2704	2807
33	Primary Metals	2339	2231	2138	2054	1979	1928
34	Fabricated Metals	7514	7336	7198	7080	6978	6953
35	Nonelectrical Machinery	6623	6631	6671	6727	6802	6957
36	Electrical Machinery	1679	1657	1644	1635	1630	1645
37	Transportation Equipment	9808	9426	9103	8812	8553	8398
38	Professional Equipment	740	459	451	444	438	438
39	Miscellaneous Products	1202	1209	1227	1242	1249	1256
	Total Employment	84589	84606	85147	85824	86579	88117

TABLE G-III

PROJECTED INDUSTRIAL EMPLOYMENT FOR LAKE COUNTY, 1970 to 2020

SIC	Description	1970	1980	1990	2000	2010	2020
20	Food and Kindred Products	1447	1885	2413	2973	3413	3732
21	Tobacco Manufactures	7	9	9	10	11	11
22	Textile Mill Products	445	545	637	735	811	888
23	Apparel	790	968	1132	1304	1440	1576
24	Lumber and Wood Products	106	127	145	163	176	188
25	Furniture and Fixtures	333	396	451	506	543	576
26	Paper and Allied Products	654	842	1034	1253	1453	1671
27	Printing and Publishing	1848	2391	3038	3736	4307	4766
28	Chemical and Allied Products	1888	2405	2926	3509	4030	4589
29	Petroleum Refining	429	540	652	775	880	988
30	Rubber and Plastic Products	650	821	990	1177	1349	1512
31	Leather Products	24	29	34	39	42	46
32	Stone, Clay and Glass	468	610	772	952	1108	1253
33	Primary Metals	3802	4547	5193	5843	6299	6732
34	Fabricated Metals	3111	3819	4489	5194	5747	6285
35	Nonelectrical Machinery	4246	5330	6389	7547	8540	9580
36	Electrical Machinery	2727	3376	3991	4649	5188	5740
37	Transportation Equipment	5527	6660	7663	8690	9439	10164
38	Professional Equipment	403	495	579	668	738	808
39	Miscellaneous Products	404	523	663	812	931	1025
	Total Employment	29308	36318	43200	50535	56436	62130

TABLE G-IV

PROJECTED INDUSTRIAL EMPLOYMENT FOR MEDINA COUNTY, 1970 to 2020

SIC	Description	1970	1980	1990	2000	2010	2020
20	Food and Kindred Products	606	772	990	1217	1406	1554
21	Tobacco Manufactures	3	4	4	4	4	5
22	Textile Mill Products	186	223	261	301	334	370
23	Apparel	331	397	464	534	593	656
24	Lumber and Wood Products	44	52	60	67	72	78
25	Furniture and Fixtures	139	162	185	207	223	240
26	Paper and Allied Products	274	345	424	513	598	696
27	Printing and Publishing	774	980	1247	1529	1774	1985
28	Chemical and Allied Products	790	986	1201	1436	1660	1911
29	Petroleum Refining	179	222	268	317	362	412
30	Rubber and Plastic Products	272	336	406	481	552	630
31	Leather Products	10	12	14	16	17	19
32	Stone, Clay and Glass	196	250	317	389	456	522
33	Primary Metals	1592	1864	2131	2391	2594	2803
34	Fabricated Metals	1303	1565	1842	2125	2367	2617
35	Nonelectrical Machinery	1778	2185	2622	3088	3517	3990
36	Electrical Machinery	1142	1384	1638	1902	2137	2390
37	Transportation Equipment	2314	2730	3145	3556	3887	4233
38	Professional Equipment	169	203	238	273	304	337
39	Miscellaneous Products	169	215	272	332	384	427
	Total Employment	12271	14887	17729	20678	23241	25875

TABLE G-V

PROJECTED INDUSTRIAL EMPLOYMENT FOR PORTAGE COUNTY, 1970 to 2020

SIC	Description	1970	1980	1990	2000	2010	2020
20	Food and Kindred Products	629	792	959	1122	1268	1356
21	Tobacco Manufactures	1	1	1	1	1	1
22	Textile Mill Products	29	36	41	47	52	56
23	Apparel	45	55	64	72	81	86
24	Lumber and Wood Products	65	77	88	97	105	110
25	Furniture and Fixtures	80	94	106	116	125	129
26	Paper and Allied Products	73	94	114	136	159	179
27	Printing and Publishing	658	883	1139	1402	1648	1804
28	Chemical and Allied Products	681	863	1043	1228	1419	1585
29	Petroleum Refining	39	49	58	68	77	85
30	Rubber and Plastic Products	9288	11662	13971	16313	18689	20687
31	Leather Products	18	22	25	28	31	33
32	Stone, Clay and Glass	489	638	800	968	1137	1270
33	Primary Metals	515	612	694	767	832	872
34	Fabricated Metals	1654	2012	2337	2644	2935	3144
35	Nonelectrical Machinery	1458	1819	2165	2512	2860	3146
36	Electrical Machinery	369	455	534	611	686	744
37	Transportation Equipment	2159	2585	2955	3291	3597	3798
38	Professional Equipment	103	126	146	166	184	198
39	Miscellaneous Products	264	332	398	464	525	568
	Total Employment	18617	23207	27638	32053	36421	39851

TABLE G-VI

PROJECTED INDUSTRIAL EMPLOYMENT FOR GEAUGA COUNTY, 1970 to 2020

SIC	Description	1970	1980	1990	2000	2010	2020
20	Food and Kindred Products	468	614	817	1042	1238	1400
21	Tobacco Manufactures	2	3	3	4	4	4
22	Textile Mill Products	144	177	216	258	294	333
23	Apparel	255	315	383	457	522	592
24	Lumber and Wood Products	34	41	49	57	64	71
25	Furniture and Fixtures	108	129	153	177	197	216
26	Paper and Allied Products	211	274	350	439	527	627
27	Printing and Publishing	597	779	1028	1310	1562	1788
28	Chemical and Allied Products	610	783	990	1230	1462	1722
29	Petroleum Refining	139	176	221	272	319	371
30	Rubber and Plastic Products	210	267	335	412	486	567
31	Leather Products	8	10	12	14	15	17
32	Stone, Clay and Glass	151	199	261	334	402	470
33	Primary Metals	1229	1481	1758	2049	2285	2526
34	Fabricated Metals	1005	1244	1519	1821	2085	2358
35	Nonelectrical Machinery	1372	1736	2163	2646	3098	3595
36	Electrical Machinery	881	1100	1351	1630	1882	2154
37	Transportation Equipment	1786	2170	2594	3046	3424	3814
38	Professional Equipment	130	161	196	234	268	303
39	Miscellaneous Products	130	171	224	285	338	385
	Total Employment	9470	11830	14623	17717	20472	23313

ATTACHMENT H

PROJECTED INDUSTRIAL

WASTE LOADS

Attachment H contains projected industrial waste loads for the period 1990-2020 by two-digit SIC classification. These values include provisions for nominal reductions in water use and water reuse.

TABLE H-I

WASTE LOADS FOR 1990

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Acidity	Oil	TKN	P	SO_4	Cl	F	CN
20	7.524	1.68	2.02	0.652	187098	428582	93359	216744	-	-	3621	7325	3350	-	-	-	-
22	0.561	0.068	-	-	2120	8492	881	9057	-	-	-	15	37.3	-	-	-	-
26	0.0144	0.49	1.85	0.144	1856	7210	1907	-	-	-	-	39	-	2245	-	-	-
28	2.23	0.223	0.676	5.52	3098	9037	22204	22204	-	-	275	1871	6.1	-	-	-	-
29	0.243	1.04	0.426	0.102	173	803	606	8365	-	-	232	-	9.9	-	-	-	-
30	14.42	1.71	8.316	103.8	15819	95238	28043	185031	-	-	1584	-	-	-	-	-	-
33	11.03	10.64	86.7	405	67055	203792	2468660	103000	-	41713	119184	10104	290	27765	109044	919	481
34	15.08	8.00	5.395	0.129	-	1923	13785	141887	25645	-	9336	-	-	-	-	-	2708
35	2.25	6.1	-	0.019	-	-	5347	112211	10282	-	5504	-	-	-	-	-	26
36	2.22	6.65	0.226	0.012	-	-	1431	21873	3395	-	852	-	-	-	-	-	0.4
37	3.109	9.05	1.778	-	-	-	6235	-	6196	-	2507	-	360	-	-	-	10.8
72,75	8.76	-	-	-	13041	34779	18012	47757	19847	-	844	508	865	-	-	-	-
Total	67.44	45.65	107.39	545.9	290260	789856	2660470	868129	65364	41713	143939	19862	4918	30010	109044	919	3226

TABLE H-I (cont'd)

WASTE LOADS
FOR 1990

SIC	Contaminant Loads (lb/day) Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Sn	Al	Mn
20	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	3.2	30.1	4.1	6.97	1.52	1934	34.3	-	-	-
29	1.98	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
33	537	-	187 49	339	476.1	254.7	393.6	2443	445516	-	-	-
34	-	24.9	1630	1569	86.1	1876	35	1239	7628	-	15	-
35	-	-	94.8	95.4	3.4	70.7	-	54.9	60.3	-	-	-
36	-	-	9.1	104	7.0	35.7	-	42	118	-	-	-
37	-	-	26.1	36.1	2.6	55.3	-	32.8	39.6	49.2	82.3	60
72,75	-	-	-	-	-	-	-	-	-	-	-	-
Total	539	24.9	1960	2173	579.3	2290	434	5746	453396	49.2	97.3	60

TABLE H-II

WASTE LOADS FOR 2000

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Acidity	Oil	TKN	P	SO_4	Cl	F	CN
20	8.298	1.857	2.231	0.719	199338	456620	99466	230978	-	-	3859	7805	3570	-	-	-	-
22	0.583	0.071	-	-	2113	8465	878	9028	-	-	-	15	37.2	-	-	-	-
26	0.016	0.538	2.02	0.157	1946	7560	1999	-	-	-	-	41	-	2354	-	-	-
28	2.41	1.4	2.61	5.95	3220	9395	23083	23083	-	-	391	1945	6.3	-	-	-	-
29	0.26	1.12	0.46	0.109	186	860	649	8956	-	-	248	-	10.6	-	-	-	-
30	15.44	1.83	8.90	111.1	16293	98124	28892	190638	-	-	-	-	-	-	-	-	-
33	12.08	11.65	91.5	427.7	72169	219335	2656948	110857	-	44895	128274	10875	312	29883	117361	989	518
34	16.93	8.99	6.06	0.145	-	2.07	15108	154786	28107	-	10233	-	-	-	-	-	2967
35	2.57	6.95	-	0.0219	-	-	6046	126885	11626	-	6224	-	-	-	-	-	29.4
36	7.50	0.255	0.014	-	-	1578	24112	3742	-	939	-	-	-	-	-	-	0.4
37	3.43	9.973	1.96	-	-	-	6755	-	6712	-	2716	-	390	-	-	-	11.7
72,75	9.35	-	-	-	13414	35775	18527	49127	20415	-	868	522	767	-	-	-	-
Total	73.85	51.88	116.0	545.9	308679	838241	2859929	908080	70602	44895	155384	21203	5093	32237	117361	989	3527

TABLE H-II (cont'd)

WASTE LOADS FOR 2000

SIC	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Sn	Al	Mn
	Contaminant Loads (lb/day)											
20			-	-	-	-	-	-	-	-	-	-
22			-	-	-	-	-	-	-	-	-	-
26			-	-	-	-	-	-	-	-	-	-
28	5.3	-	3.4	31.3	4.3	7.2	1.6	2011	35.7	-	-	-
29	2.1	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
33	578	-	202	365	512.4	264.4	424	2629	479496	-	-	-
34	-	27.3	1778	1711	94.4	2047	38	1351	8322	-	16.4	-
36	-	-	107.2	107.9	3.8	80	-	62	68.2	-	-	-
37	-	-	10.1	144.2	7.7	39.3	-	46.3	130	-	-	-
72,75	-	-	39.1	39.1	2.9	60	-	35.5	42.9	53.3	90	66
Total	585	27.3	2140	2398	626	2498	463	6135	488027	53.3	106	66

TABLE H-III

WASTE LOADS FOR 2010

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Acidity	Oil	TKN	P	SO_4	Cl	F	CN
20	8.86	1.983	2.383	0.767	207760	472641	102957	239026	-	-	3994	8078	3694	-	-	-	-
22	0.601	0.073	-	-	2136	8556	887	9125	-	-	-	15	38	-	-	-	-
26	0.017	0.59	2.2	0.17	2054	7980	2110	-	-	-	-	43.3	-	2485	-	-	-
28	2.29	0.26	2.8	6.39	3374	9843	24182	24182	-	-	409	2037	6.6	-	-	-	-
29	0.276	1.18	0.48	0.115	184	852	643	8871	-	-	246	-	10.5	-	-	-	-
30	16.32	1.93	9.41	117.5	17273	101010	29742	196245	-	-	1680	-	-	-	-	-	-
33	12.65	12.2	92.3	431.5	74010	227971	2761552	115222	-	46662	133324	11303	325	31060	121981	1028	539
34	18.29	9.71	6.51	0.16	-	2261	16211	166394	30159	-	10979	-	-	-	-	-	3184
35	2.848	7.72	-	0.024	-	-	6581	138106	12654	-	6774	-	-	-	-	-	32
36	2.67	7.99	0.27	0.015	-	-	1702	26007	4036	-	1013	-	-	-	-	-	0.5
37	3.61	10.51	2.06	-	-	-	7067	-	7022	-	2841	-	408	-	-	-	12.2
72,75	9.93	-	-	-	13863	36971	19146	42863	21097	-	898	538	689	-	-	-	-
Total	78.36	54.14	118.4	556.6	320654	868085	2972780	966041	74968	46662	162158	22014	5171	33545	121981	1028	3768

TABLE H-III (cont'd)

WASTE LOADS FOR 2010

SIC	Contaminant Loads (lb/day) Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Sn	Al	Mn
20	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
28	5.5	-	3.5	32.8	4.5	7.6	1.7	2107	37.4	-	-	-
29	2.1	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
33	601	-	210	378	533	275	440	2732	498374			
34	-	29.3	1912	1840	101.3	2200	41	1452	8946	-	17.6	-
35	-	-	116.6	117.4	4.2	87.0	-	67.5	74.2	-	-	-
36	-	-	10.9	155.5	8.3	42.4	-	50	140	-	-	-
37	-	-	40.9	40.9	3.0	62.7	-	37.1	44.9	56	94	69
72,75	-	-	-	-	-	-	-	-	-	-	-	-
Total	609	29.3	2293	2564	654.3	2675	483	6446	507617	56	112	69

TABLE H-IV

WASTE LOADS FOR 2020

SIC	Wastewater Flow (mgd) City Process	City Cooling	Stream Process	Stream Cooling	Contaminant Loads (lb/day) BOD	COD	SS	TDS	Alk	Acidity	Oil	TKN	P	SO_4	Cl	F	CN
20	9.212	2.062	2.477	0.798	208082	476647	103829	241052	-	-	4027	8.46	3726	-	-	-	-
22	0.625	0.076	-	-	2204	8829	9.6	9416	-	-	-	15.5	38.8	-	-	-	-
26	0.0186	0.638	2.394	0.186	2234	8680	2295	-	-	-	-	47.1	-	2703	-	-	-
28	2.785	0.281	3.017	6.883	3619	10559	25941	25941	-	-	439	2185	7.1	-	-	-	-
29	0.294	1.264	0.516	0.124	196	908	685	9463	-	-	262	-	11.2	-	-	-	-
30	17.48	2.069	10.08	125.9	18050	108706	32008	211197	-	-	1808	-	-	-	-	-	-
33	12.93	12.48	91.5	427.7	76147	231425	2803394	116968	-	47369	135344	11474	330	31530	123829	1044	547
34	19.16	10.17	6.86	0.16	-	2338	16763	172844	31185	-	11353	-	-	-	-	-	3292
35	3.06	8.288	-	0.026	-	-	7033	147600	13524	-	7240	-	-	-	-	-	34
36	2.905	8.683	0.295	0.016	-	-	1792	27385	4250	-	1067	-	-	-	-	-	0.5
37	3.715	10.82	2.125	-	-	-	7222	-	7177	-	2904	-	417	-	-	-	12.5
72,75	10.61	-	-	-	14816	39515	20476	54261	22548	-	959	576	736	-	-	-	-
Total	82.9	56.83	119.3	561.75	325348	887661	3022343	1016127	78684	47369	165403	22444	5266	34233	23829	1044	3886

TABLE H-IV (cont'd)

WASTE LOADS FOR 2010

SIC	Contaminant Loads (lb/day)											
	Phenol	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe	Sn	Al	Mn
20	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
28	5.9	-	3.8	35.2	4.8	8.1	1.8	2260	40.1	-	-	-
29	2.2	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
33	610	-	213	384	541	279	447	2774	505925	-	-	-
34	-	30.2	1986	1910	104.7	2286	43	1509	9293	-	18.2	-
35	-	-	125	125.5	4.4	93.0	-	72.2	79.3	-	-	-
35	-	-	11.4	164	8.7	44.7	-	52.6	148	-	-	-
37	-	-	41.8	41.8	3.06	64.1	-	37.9	45.9	57	96	70
72,75	-	-	-	-	-	-	-	-	-	-	-	-
Total	618	30.2	2381	2660	666.7	2775	492	6706	515531	57	114.2	70

ATTACHMENT J

WASTE FLOWS AND HEAVY METAL LOADS

DISCHARGED TO MUNICIPAL SEWER SYSTEMS

This attachment contains projected heavy metal loads which would be discharged to municipal sewer systems following pretreatment and the total projected industrial flows discharged to municipal systems.

Treatment alternatives referred to in these tables are identified in the Phase II report.

TABLE J-I

METALS DISCHARGED TO SEWER SYSTEMS AFTER PRETREATMENT

ALTERNATIVE 1

Year	Sewer District	Contaminant Loads (lb/day)							
		Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe
1970	Akron	0.72	4.72	3.02	7.82	3.57	0.23	2.42	29.7
	Bedford	0.06	1.89	3.66	1.14	0.76	-	1.30	11.34
	Cleveland Easterly	3.9	18.6	8.44	18.5	11.75	-	10.33	161
	Cleveland Southerly	2.1	10.1	5.27	2.51	8.72	22	34.27	28.6
	Cleveland Westerly	7.03	4.35	5.65	5.51	9.79	1.5	9.0	82.6
	Summit Unsewered	0.29	0.23	0.99	0.78	0.35	-	0.69	2.11
	Twinsburg	-	0.6	3.0	0.3	0.46	-	0.76	1.04
	Willoughby	-	2.22	2.33	1.22	1.19	-	1.09	4.31
	Total	14.1	42.7	32.4	37.8	36.6	23.7	59.8	1021
1990	Akron	0.81	5.66	3.35	8.75	4.43	0.25	3.66	32.62
	Bedford	0.07	2.17	4.20	1.31	0.87	-	1.45	13.04
	Cleveland Easterly	4.5	21.0	9.54	19.39	13.28	-	12.24	181.9
	Cleveland Southerly	2.4	11.4	5.84	4.1	9.6	23.8	38.4	32.0
	Cleveland Westerly	8.09	5.00	6.5	6.36	11.26	1.7	9.9	95.0
	Summit Unsewered	0.33	0.25	1.09	0.88	0.39	-	0.76	2.36
	Twinsburg	-	0.65	3.27	0.32	0.50	-	0.83	1.13
	Willoughby	3.78	3.92	2.07	2.02	-	1.82	7.33	
	Total	16.2	49.9	37.7	43.2	42.3	25.7	69.1	365.4
2020	Akron	0.90	6.54	3.68	9.67	4.92	0.77	4.05	37.07
	Bedford	0.08	2.41	4.68	1.46	0.96	-	1.57	14.50
	Cleveland Easterly	5.0	23.4	10.26	21.32	14.67	-	13.4	191.5
	Cleveland Southerly	2.7	12.6	6.31	4.6	10.6	25.0	42.1	35.2
	Cleveland Westerly	8.99	5.57	7.23	7.0	12.5	1.9	10.77	105.3
	Summit Unsewered	0.36	0.27	1.17	0.96	0.42	-	0.81	2.58
	Twinsburg	-	0.67	3.36	0.34	0.52	-	0.85	1.17
	Willoughby	-	6.06	6.17	3.28	3.24	-	2.84	11.68
	Total	18.0	57.5	42.9	48.6	47.8	27.2	76.4	399

TABLE J-II

METALS DISCHARGED TO SEWER SYSTEMS AFTER PRETREATMENT

ALTERNATIVE 2

		Contaminant Loads (lb/day)							
Year	Sewer District	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe
1970	Akron	0.72	1.20	0.79	2.06	0.1	0.23	0.64	12.2
	Bedford	0.03	0.59	1.21	0.40	0.33	-	0.59	5.34
	Cleveland Easterly	1.0	0.72	1.04	11.58	1.36	-	0.37	76.3
	Cleveland Southerly	1.1	5.35	5.20	1.26	6.75	22	21.6	9.17
	Cleveland Westerly	3.51	2.1	3.3	2.75	7.42	0.55	4.95	40.7
	Summit Unsewered	0.15	0.11	0.50	0.39	0.16	-	0.24	1.05
	Twinsburg	-	0.3	1.5	0.3	0.46	-	0.76	1.04
	Willoughby	-	0.91	0.98	0.61	0.54	-	0.54	1.79
	Total	6.5	17.7	14.5	19.35	17.9	22.8	29.7	146.7
1990	Akron	0.41	1.52	2.54	2.40	1.22	0.10	1.20	14.25
	Bedford	0.04	0.67	1.39	0.47	0.38	-	0.72	6.14
	Cleveland Easterly	1.13	9.91	3.79	9.22	5.49	-	6.52	88.4
	Cleveland Southerly	1.2	6.68	3.2	2.39	7.06	23.1	23.59	8.0
	Cleveland Westerly	4.05	2.5	3.9	3.17	8.54	0.62	5.45	46.9
	Summit Unsewered	0.17	0.12	0.54	0.44	0.17	-	0.38	1.18
	Twinsburg	-	0.32	1.62	0.32	0.50	-	0.82	1.12
	Willoughby	-	1.55	1.64	1.04	0.91	-	0.90	3.03
	Total	7.0	23.3	18.6	19.4	24.3	23.7	39.6	169.0
2020	Akron	0.45	1.23	1.78	1.73	0.92	0.08	1.01	15.31
	Bedford	0.04	0.74	1.55	0.52	0.42	-	0.78	6.83
	Cleveland Easterly	1.25	11.17	4.03	10.02	6.09	-	6.6	93.76
	Cleveland Southerly	1.35	7.31	3.48	2.59	7.64	25.6	25.02	18.8
	Cleveland Westerly	4.5	2.8	4.33	3.48	9.40	0.8	5.89	54.7
	Summit Unsewered	0.19	9.23	9.59	0.48	0.19	-	0.40	1.28
	Twinsburg	-	0.34	1.68	0.34	0.52	-	0.85	1.16
	Willoughby	-	2.48	2.57	1.65	1.46	-	1.4	4.82
	Total	7.78	25.9	20.0	20.8	25.7	26.5	42	197

TABLE J-III

METALS DISCHARGED TO SEWER SYSTEMS AFTER PRETREATMENT

ALTERNATIVE 5

		Contaminant Loads (lb/day)							
Year	Sewer District	Ag	Cu	Cr	Cd	Ni	Pb	Zn	Fe
1970	Akron	0.72	219	65	15.48	200	30	350	1878
1970	Bedford	0.62	146.4	249	1.14	4.92	-	55.3	15.14
1970	Cleveland Easterly	3.9	254.2	832	34.3	480	-	98.3	1140.5
1970	Cleveland Southerly	2.1	535	334	8.02	289	1	1765	1328
1970	Cleveland Westerly	7.04	474	696	9.02	622	2.8	115	7177
1970	Summit Unsewered	2.9	1.4	19.7	0.79	2.08	-	1.9	8.1
1970	Twinsburg	-	3	30	0.3	0.46	-	0.76	1.04
1970	Willoughby	-	2.27	39.87	1.22	3.37	-	1.48	527.1
	Total	17.3	1637	2266	70.3	1602	34	2387	12075
1990	Akron	0.81	247	73	17.6	226	34	395	2273
	Bedford	0.71	165	287	11.31	5.65	-	60.38	17.37
	Cleveland Easterly	4.49	290.9	958.8	35.3	552	-	112.8	1305
	Cleveland Southerly	2.42	610	395	9.3	331	0.94	1759	1529
	Cleveland Westerly	8.09	545	789.6	10.36	715	3.22	131.8	8249
	Summit Unsewered	3.45	1.45	22.74	0.88	2.36	-	2.2	9105
	Twinsburg	-	3.24	32.4	0.32	0.50	-	0.82	1.12
	Willoughby	-	3.87	68.1	2.13	5.74	-	2.48	902.2
	Total	20.0	2018	2627	77.2	1838	38	2465	14286
2020	Akron	0.90	274	81	19.3	250	37	437	2347
	Bedford	0.79	187	320	1.46	6.29	-	62.17	19.25
	Cleveland Easterly	4.9	321.8	1069	38.6	610.9	-	124	1441
	Cleveland Southerly	2.6	670.4	440	10.5	368	0.98	1888	1686
	Cleveland Westerly	9.0	606	879	11.5	796	3.58	146	9181
	Summit Unsewered	4.15	1.60	25.12	0.96	2.61	-	2.41	9.77
	Twinsburg	-	3.36	33.6	0.34	0.51	-	0.85	1.16
	Willoughby	-	6.20	109.4	3.28	9.21	-	3.89	1450
	Total	19.7	2071	2951	86.1	2044	42	2664	16136

TABLE J-IV

INDUSTRIAL WASTEWATER DISCHARGES TO MUNICIPAL SEWERS

FOR TREATMENT ALTERNATIVES 1 AND 3

Sewer District	Process Flow			Cooling Flow		
	1970	1990	2020	1970	1990	2020
Akron	15.196	14.778	16.758	4.916	5.798	6.567
Bedford	0.811	0.850	0.971	0.229	0.242	0.273
Bedford Heights	0.606	0.618	0.706	0.657	0.697	0.752
Berea	0.235	0.241	0.265	0.314	0.340	0.371
Brook Park	0.027	0.030	0.034	0.093	0.102	0.113
Burton	0.057	0.087	0.154	0.058	0.085	0.154
Chagrin Falls	0.154	0.159	0.181	0.019	0.022	0.026
Chardon	0.339	0.484	0.856	0.011	0.020	0.029
Chesterland[a]	0.038	0.058	0.105	0.126	0.217	0.409
Clev. Easterly	12.050	13.437	15.884	7.562	8.935	10.316
Clev. Southerly	20.820	22.377	24.531	10.808	11.848	13.123
Clev. Westerly	6.901	7.597	8.741	4.052	4.337	4.965
Cuyahoga Uns.[b]	0.107	0.125	0.177	0.591	0.690	0.851
Euclid	1.868	2.123	1.788	2.632	3.013	3.531
Geauga Uns.[c]	0.015	0.026	0.050	0.015	0.027	0.054
Hudson	0.302	0.337	0.395	0.016	0.018	0.021
Kent	2.196	3.608	5.819	0.467	0.776	1.335
Lake Uns.[d]	0.272	0.444	0.738	0.261	0.454	0.797
Lakewood	0.191	0.209	0.240	0.037	0.042	0.050
Lorain Uns.[e]	0.022	0.036	0.061	0.012	0.020	0.033
Macedonia	0.010	0.011	0.012	0.003	0.004	0.005
Mantua	0.126	0.170	0.261	-	-	-
Medina	0.297	0.451	0.742	0.500	0.763	1.215
Medina Uns.[f]	0.484	0.682	1.272	-	-	-
Middleburg Hts.	0.053	0.058	0.067	-	-	-
Middlefield	0.584	0.833	1.474	0.040	0.061	0.112
No. Olmstead	0.128	0.140	0.160	0.002	0.002	0.002
Strongsville[g]	0.125	0.136	0.157	0.006	0.007	0.008
Portage Uns.[h]	0.011	0.028	0.045	0.011	0.017	0.029
Ravenna	0.574	0.773	1.191	0.379	0.595	0.910
Rocky River	0.367	0.404	0.460	0.130	0.137	0.161
Solon	0.493	0.532	0.583	0.551	0.618	0.699
Stark Uns.[i]	0.025	0.034	0.050	0.001	0.002	0.003
Streetsboro	0.005	0.008	0.013	0.011	0.018	0.029
Summit Uns.[j]	1.342	1.287	1.458	1.771	2.012	2.368
Twinsburg	0.288	0.305	0.857	2.013	2.445	2.977
Willoughby	1.325	1.997	3.252	0.534	0.937	1.592
Total	68.444	75.503	90.510	38.827	45.305	53.920

FOOTNOTES TO TABLE J-IV

a. Changed to Fairmont Road by 1980.

b. To be included in Cleveland Southerly District by 1980.

c. All unsewered flow originates in Newbury; area still unsewered in 1980.

d. All unsewered flow originates in Mentor; area still unsewered in 1980.

e. Included in North Olmstead by 1980.

f. Included in Medina District by 1980.

g. Strongsville to be included in North Olmstead by 1980.

h. Unsewered flows originate in Rootstown (area still unsewered in 1980) and Aurora (separate district by 1980).

i. All flow originates in Hartville; discharge into Mahoning River Basin.

j. Flows to be included in Akron.

TABLE J-5

INDUSTRIAL DISCHARGES TO MUNICIPAL SEWERS

FOR TREATMENT ALTERNATIVE 2

Sewer District	Process Flow			Cooling		
	1970	1990	2020	1970	1990	2020
Akron	5.346	5.319	6.066	1.643	1.933	2.189
Bedford	0.372	0.378	0.431	0.086	0.081	0.091
Bedford Heights	0.303	0.299	0.341	0.228	0.232	0.251
Berea	0.114	0.114	0.126	0.104	0.113	0.124
Brook Park	0.017	0.014	0.017	0.032	0.034	0.038
Burton	0.032	0.044	0.077	0.023	0.028	0.051
Chagrin Falls	0.089	0.079	0.090	0.007	0.007	0.009
Chardon	0.165	0.241	0.429	0.004	0.007	0.010
Chesterland[a]	0.020	0.040	0.073	0.042	0.072	0.136
Cleveland Easterly	6.173	6.732	7.961	2.520	2.979	3.439
Cleveland Southerly	11.130	11.750	13.080	3.602	3.949	4.374
Cleveland Westerly	3.406	3.693	4.266	1.350	1.446	1.655
Cuyahoga Unsewered[b]	0.043	0.050	0.072	0.197	0.230	0.284
Euclid	0.914	0.988	1.084	0.877	1.004	1.177
Geauga Unsewered[c]	0.009	0.012	0.024	0.005	0.009	0.018
Hudson	0.150	0.168	0.197	0.005	0.006	0.007
Kent	0.916	1.512	2.438	0.156	0.259	0.445
Lake Unsewered[d]	0.113	0.184	0.303	0.087	0.151	0.266
Lakewood	0.093	0.101	0.116	0.012	0.014	0.017
Lorain Unsewered[e]	0.010	0.014	0.024	0.004	0.007	0.011
Macedonia	0.005	0.005	0.006	0.001	0.001	0.002
Mantua	0.062	0.085	0.130	-	-	-
Medina	0.141	0.214	0.344	0.167	0.254	0.405
Medina Unsewered[f]	0.241	0.341	0.636	-	-	-
Middleburg Hts.	0.029	0.029	0.034	-	-	-
Middlefield	0.295	0.426	0.154	0.013	0.020	0.037
North Olmstead	0.063	0.070	0.080	0.001	0.001	0.001
Portage Unsewered[g]	0.006	0.008	0.012	0.004	0.006	0.010
Ravenna	0.289	0.390	0.600	0.126	0.198	0.303
Rocky River	0.173	0.191	0.217	0.043	0.046	0.054
Solon	0.249	0.268	0.293	0.184	0.206	0.233
Streetsboro	0.002	0.003	0.005	0.004	0.006	0.010
Strongsville[h]	0.064	0.070	0.080	0.001	0.002	0.003
Summit Unsewered[i]	0.756	0.720	0.817	0.590	0.671	0.789
Twinsburg	0.135	0.142	0.407	0.671	0.815	0.992
Willoughby	0.622	0.932	1.514	0.178	0.312	0.531
Totals	26.547	36.059	44.129	12.942	15.099	17.963

FOOTNOTES TO TABLE J-V

a. Changed to Fairmont Road by 1980.

b. To be included in Cleveland Southerly District by 1980.

c. All unsewered flow originates in Newbury; area still unsewered in 1980.

d. All unsewered flow originates in Mentor; area still unsewered in 1980.

e. Included in North Olmstead by 1980.

f. Included in Medina District by 1980.

g. Unsewered flows originate in Rootstown (area still unsewered in 1980) and Aurora (separate district by 1980).

h. Strongsville to be included in North Olmstead by 1980.

i. Flows to be included in Akron.

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WASTEWATER MANAGEMENT STUDY
FOR CLEVELAND-AKRON METROPOLITAN
AND THREE RIVERS WATERSHED AREAS

INDUSTRIAL WASTEWATER STUDY
SUMMARY REPORT

Prepared by

ASSOCIATED WATER AND AIR RESOURCES ENGINEERS, INC.

2907 12th Avenue South
Nashville, Tennessee 37204

Contract No.: DACW49-72-C-0049
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INTRODUCTION

THE CONCERN FOR POLLUTION IN THE THREE RIVERS AREA

The magnitude of the industrial wastewater problem in the Three Rivers Watershed area is indicated by the fact that approximately 65 percent of the wastewater influent to Lake Erie in Northeastern Ohio in 1970 originated from industry. Principal industries in the area include iron and steel production, fabricated metal products including manufacturers of electrical machinery, transportation equipment, and rubber products. The great requirements for water in all of these industries dictate that proper consideration of industrial water use and wastewater production be made in planning for water resources management. Failure to provide for adequate water supply would stifle the growth of these industries in the future. Conversely, industrial wastewater contributions will be significant in evaluating the effect of waste management policies on overall water quality. Attempts to identify the regional economic impact of achieving various degrees of water quality improvement would be meaningless without consideration of industrial wastewater treatment required. The effort of this investigation was concentrated toward identifying industrial wastewater loads produced in the Three Rivers Watershed area and defining methods of treating these waters to meet existing and anticipated water quality standards.

Water pollution in the Lake Erie Basin and in particular, the Cleveland-Akron area has attracted considerable attention in the last few years as the country has become more concerned with water quality. While problems in the lake have perhaps been overstated at times by those anxious to promote special environmental causes, it is generally acknowledged that problems do exist in the Lake Erie basin. Although the water quality of the lake as a whole generally meets Aquatic Life A standards of the State of Ohio, localized problems do exist at points of discharge into the lake, and along the shoreline. Among the most significant problems are high bacterial counts, accelerated eutrophication, noticeable concentrations of oil, and contamination from heavy metals.

In addition water pollution problems in the Cleveland-Akron area have contributed to pollution of the Rocky, Cuyahoga, and Chagrin Rivers. The effluent from 122 municipal wastewater treatment facilities contributes approximately 380 mil gal of domestic and industrial wastes to the rivers and to Lake Erie daily. In addition at least 135 industries discharge wastes directly to streams in the area. Controlling and treating discharges from the 5,000 industrial establishments in the Study Area is a task which has not completely been brought under control by local and state regulatory authorities. While some wastes receive adequate treatment, others do not. Municipal treatment systems are frequently inadequate to properly treat industrial wastes discharged to them. Spills and batch discharges of toxic substances to sewers make proper operation of wastewater treatment facilities a difficult task.

However, if industry has been reluctant to fully commit itself to pollution control, the lack of coordination among various regulatory authorities should be mentioned as one source of confusion in efforts to manage water quality. The passage of the 1972 ammendments to the Water Pollution Control Act by Congress in late 1972 largely alleviated this confusion. The development of final industrial effluent guidelines and the issuance of discharge permits should provide the assurance industries need regarding enforcement schedules and set forth the authority needed to implement standards. These steps will largely overcome the resistance of industry in the last few years to implement extensive pollution abatement programs involving very substantial capital expenditures. The apprehension toward current wastewater management planning and confusion concerning sources of action being considered were perhaps best summarized in the 1971 Three Rivers Watershed District Annual Report.

> 1971....There was some action. There was a lot of talk. There were suits filed. New legislation was formulated. New words and pharases came into vogue; regionalization, cost effectiveness, zero discharge, their meanings and implications not clear. There was hesitation; phosphates, 1899 enforcement, stream quality based on stream uses, do they mean it or don't they? Who is "they," the State or the Federal Government? There was delay; approval by council, approval by State Health, approval by State

Natural Resources, approval by Water Pollution Control Board, approval by Water Development Authority, approval by Federal Environmental Protection Agency, approval by Federal Housing and Urban Development, Plan certifications, agency certifications, environmental impact statements. Are we over-checking? Is Federal funding suffocating local initiative? Is it worth the cost, to people, to the environment? It was the year of questions.

THE WASTEWATER MANAGEMENT PROGRAM

In 1970 Congress commissioned the Army Corps of Engineers to conduct a pilot program in five areas of the country to develop and evaluate a range of alternative regional systems capable of alleviating wastewater problems. One of the areas chosen was the Three Rivers Watershed area in Northeastern Ohio including the industrial centers of Cleveland and Akron.

Feasibility studies prepared during the first part of the program identified present and future wastewater management problems and made a preliminary evaluation of the feasibility and consequences of alternative wastewater management programs. The survey-scope studies, of which this investigation is a part, have as their purpose the refinement of base data and the estimation of treatment costs associated with alternative management programs.

The Wastewater Management Program for the Cleveland-Akron area was developed by three contractors. Responsibilities of the various contractors included:

1. Definition of the industrial waste problem in the Study Area.
2. Definition and resolution of the domestic and stormwater runoff problem.
3. Formulation of generalized alternative regional management systems.

Because of the high concentration of industries in the Cleveland-Akron area, specific treatment of industrial waste problems was considered essential in the formulation of the Wastewater Management Program. According to the 1967 Census of Manufacturers, the more than 5,000 industrial establishments located in the Cleveland and Akron Standard Metropolitan Statistical Areas employed 408,000 persons and added approximately $5,700,000,000 to the regional economy. Thus, the implementation of regional wastewater management plans will affect not only the recreational and aesthetic needs of the population, but perhaps the economic opportunities available to them.

OBJECTIVES

This specialty appendix contains the results of the investigation related to the identification of industrial wastewater treatment technology for the Three Rivers Watershed area. The primary objective

of the investigation was to identify industrial wastewater loads produced in the Study Area and to estimate the cost of technology required for treatment of these wastes. Treatment designs were developed to achieve two water quality goals: State of Ohio standards presently being implemented by the State Environmental Protection Agency and "no discharge of critical pollutants" goals proposed by the U. S. Army Corps of Engineers.

Work in the investigation was divided into three phases. This report contains a summary of the most important aspects of the study and three phase reports in which details of the work, approach rationale, and discussions of the results are presented.

Specific objectives of each of the contract phases may be enumerated as follows:

1. To inventory significant industrial waste loads discharged in the Study Area at the present time and to project these loads to the years 1990-2020.
2. To design and estimate the cost of constructing and operating treatment facilities required for major industries in the Study Area to comply with anticipated water quality standards.
3. To identify the fraction of the cost of municipal waste management systems which would be borne by industry for the treatment of industrial wastes in combined systems.

DEVELOPMENT OF TECHNICAL GOALS

AND TREATMENT ALTERNATIVES

TECHNICAL GOALS

Initially two water quality goals were selected as the technical basis of this investigation. Water standards established by the Ohio Water Pollution Control Board (now the Ohio Environmental Protection Agency) were based on the attainment of stream standards required for various water uses. These standards were referred to as "Level I" goals in this study. A more strict goal was proposed by the Office, Chief of Engineers to achieve the "no discharge of critical pollutants" level of treatment set forth in the 1972 Water Pollution Control Act. This goal was presented as effluent levels which were applied to each wastestream. This goal was referred to as "Level II."

Because water quality standards are the subject of much discussion both at the state and federal level at the present time, it should not be assumed that the treatment criteria specified in this investigation are indicative of standards which will finally be adopted. State goals used in this study were based on effluent standards proposed to achieve stream standards which had been established as of June, 1972. The "no discharge of critical pollutants" standards were based on an interpretation by the Corps of Engineers of the treatment level required to achieve present federal water quality goals. However, firm guidelines have not yet been established by the U. S. Environmental Protection Agency.

The treatment required of industry in the Study Area for compliance with these water quality standards predominately included removal of heavy metals, suspended solids, and other toxic materials. In most all cases wastes requiring removal of organic materials were discharged to municipal systems. A summary of the effluent levels specified for the most important waste constituents is presented in Table I. A detailed disucssion of water quality standards is given in the Phase I report. Level II standards were, in some instances, modified upward to reflect the capabilities of best currently available technology. Even with these modifications it was not possible to strictly meet Level II suspended solids concentrations in two instances. From Table I it can be seen that the principal difference in the two treatment levels for the specified constituents is in the total dissolved solids requirements.

The exact application of state and federal water quality standrads to industrial wastestreams cannot yet be determined in some cases. For the purposes of this investigation, the following assumptions were made regarding the application of these standards:

1. For discharges to municipal sewer systems constituents which would not be reduced to satisfactory levels in municipal treatment plants must be reduced by the industry to acceptable levels.
2. Dilution of one process wastestream with another cannot be used for compliance with water quality criteria.

TABLE I

WATER QUALITY GOALS FOR INDUSTRIAL WASTE TREATMENT[a]

Constituent	Level I Requirement	Level I Process Capability	Level II Requirement[b]	Level II Process Capability
Suspended Solids	8 - 18	5 - 10	5	< 5 - 10
Heavy Metals[c]	0.01 - 5.0	0.1 - 5	d	< 0.1 - 0.5
Cyanide	0.2	< 0.1	e	< 0.1
Phenol	0.3	0.3	e	< 0.1
Oil and Grease	10	10	5 - 10	5
Total Dissolved Solids	2,500	2,500	500	500

[a]All values given in mg/l.
[b]Values given are for modified Level II standards based on best available treatment.
[c]Range given for most commonly found metals.
[d]Concentrations to be reduced to levels attainable by one-stage precipitation and filtration or equivalent treatment.
[e]Concentrations to be reduced to values attainable using best available technology.

3. Criteria which apply to a point discharge on a stream were assumed to also apply to discharges to municipal systems.

Treatment processes used to meet these technical goals generally represented the best technology presently available which has been tested in demonstration or full-scale facilities. The primary exception to this was treatment required to meet total dissolved solids criteria. Three candidate process systems which might be used for demineralization include reverse osmosis, ion exchange, and distillation. In most cases, the application of these processes to the wastes from major industries generated in the Study Area has not been proven. However, developments currently being made, especially in the field of reverse osmosis, increase the possibility that existing technological problems will be overcome in several years.

While maximum reuse of water by industry was considered as one alternative open to industry, it was not possible to propose water reuse schemes which would eliminate waste discharges from industries producing difficult to treat wastes. In many cases consultation with process specialists of individual industries would be required to identify water quality requirements and possible manufacturing process modifications required for closed loop water use.

DESIGN CRITERIA

Data used as the basis of industrial designs was obtained primarily from a recent industrial wastewater survey of the Cleveland area. Because

sampling of individual wastestreams was beyond the scope of this investigation, these data formed the basis of the industrial wastewater inventory assembled in the Phase I report. Additional data sources included Corps of Engineers discharge permit applications and information obtained from local regulatory agencies and industries. A summary of existing wastewater loads produced in the Study Area is presented in Table II. Additional constituents inventoried are included in the Phase I report. These loads are ones which would result before any treatment and are considerably greater than the quantity presently being discharged to waterways. Included in this inventory are 15 of the 22 industrial categories in the Study Area. Of the 22 industrial categories in the Study Area, only 17 discharge waste volumes of any significance. The volume of waste accounted for in the inventory accounted for approximately 93 percent of the process flow and greater than 99 percent of the cooling flow generated in the Study Area according to previous studies. Details of the inventory procedure are discussed in the Phase I report.

Projections of existing waste loads to future conditions were made in order to plan for wastewater management through the year 2020. A projection model was developed which included the following considerations:

1. Projections of industrial employment.
2. Changes in the level of manufacturing technology.
3. Waste reduction practices which could be implemented without extensive plant modifications.

TABLE II

EXISTING INDUSTRIAL WASTEWATER LOADS

PRIOR TO TREATMENT

	Discharged to Municipal Sewers[a]	Discharged to Waterways[a]
Process Flow	63	102
Cooling Flow	39	468
BOD	168,000	97,000
COD	490,000	218,000
Suspended Solids	128,000	2,129,000
Total Dissolved Solids[b]	430,000	182,000
Oil	25,000	100,000
Nitrogen	5,000	11,000
Phosphorus	4,000	1,000
Cyanide	1,200	1,100
Copper	900	900
Chromium	1,600	800
Cadmium	70	400
Nickel	1,100	700
Lead	50	300
Zinc	800	4,000
Iron	7,000	383,000

[a]Values in lb/day except for flow which is given in mgd.
[b]Includes only contribution from wastes containing more than 500 mg/l TDS.

4. Changes in worker productivity.

A summary of projected waste flows and principal waste constituents is given in Table III. Projections of additional waste constituents are contained in the Phase I report. These projections reflect the relatively slow growth in industrial employment predicted for the Cleveland-Akron area in the next 50 yr.

From wastewater characterization data contained in the industrial wastewater inventory, industries which would incur the greatest treatment costs were selected to be included in the design and cost phase of the investigation. Design examples developed included the most effective and reliable processes available for achieving Level I and II standards. Designs were based on 1990 conditions with flexibility to meet 2020 needs. Treatment of major industrial wastes discharged directly to waterways and pretreatment of major wastes required for discharge to municipal systems was provided. Items contained in each design included treatment of all waterborne wastes, sludge handling, and transport of sludges and brines to disposal sites. Specific processes included in each design and the rational for process selections are contained in the Phase II report. Major industries selected for the designs included chemical manufacturing, petroleum refining, rubber products, primary metals, fabricated metal products, electrical machinery, nonelectrical machinery, and transportation equipment.

ALTERNATIVES DEVELOPED

Treatment sequences were designed and costed for five treatment

TABLE III

PROJECTED INDUSTRIAL RAW WASTE LOADINGS

FOR 1990 - 2020[a]

Constituent	1990	2000	2010	2020
Process Flow (Municipal Sewers)	67	74	78	83
Cooling Flow (Municipal Sewers)	46	52	54	57
Process Flow (Waterways)	107	116	118	119
Cooling Flow (Waterways)	515	546	557	562
BOD	290,000	309,000	320,000	325,000
COD	790,000	838,000	868,000	888,000
Suspended Solids	2,660,000	2,860,000	2,973,000	3,022,000
Total Dissolved Solids[b]	868,000	908,000	966,000	1,016,000
Heavy Metals[c]	13,000	14,000	15,000	15,000

[a]Values given are lb/day except for flows which are mgd.
[b]Values include only discharges containing more than 500 mg/l TDS.
[c]Includes sum of copper, chromium, cadmium, nickel, lead, and zinc discharges.

levels. The provisions for each alternative are summarized in Table IV. Two of the alternatives were intended to provide estimates of the cost required to treat industrial wastes to Levels I and II as defined earlier. The purpose of the additional alternatives was to determine the effect of reductions in costs which would be realized by changes in required treatment levels.

Alternative 1 was designed to meet proposed Level I treatment criteria. Treatment for Alternative 2 was capable of meeting Level II standards. In addition it was assumed that industries would implement maximum water reuse techniques in treating to this level. In order to provide an estimate of reductions in treatment costs which would result from reusing water, Alternative 3 was costed to include Level II treatment at waste flows identical to those used in Alternative 1. Alternatives 4 and 5 were designed to provide estimates of reductions in treatment costs which would result if heavy metals and total dissolved solids criteria were waived for discharges to municipal systems.

In all treatment alternatives the wastes from most industries were discharged to municipal systems. While pretreatment required of many metal fabricating industreis would be sufficient for direct discharge to waterways, most of these industries are not located adjacent to streams. The present policy of major municipalities in the Study Area is to encourage the discharge of industrial process wastes to sewers, and it is likely that these policies will not change. For Alternatives 4 and 5 which were developed for possible application to land treatment

TABLE IV

SUMMARY OF INDUSTRIAL TREATMENT ALTERNATIVES

Treatment Alternative	Treatment Criteria: Waste Discharged to Waterways	Treatment Criteria: Waste Discharged to Municipal Sewers	Waste Flows
1	Level I	Level I	Present flows with nominal reductions in water use for projected flows.
2	Level II	Level II	Maximum reuse of water.
3	Level II	Level II	Same as for Alternative 1.
4	Level II	Level II without heavy metals limitations.	Same as Alternative 1 except that all flows but those from steel mills treated in municipal systems.
5	Level II	Level II without heavy metals or TDS limitations.	Same as Alternative 4.

systems, all wastes except those from the steel industry were discharged to municipal systems.

For the implementation of maximum feasible reuse of water assumed for Alternative 2, waste discharges to municipal systems were reduced by approximately 75 percent. While the degree of water reuse practiced by industry will be influenced by the cost of necessary in-plant changes, this indicates that a major reduction of user charges paid to municipalities would result from water reduction techniques. Some of the water reuse techniques for major industries which were applied included recirculation of water in gas cooling systems in steel mills and foundries, installation of recirculated coolant systems in rolling mills, use of countercurrent rinses, conductivity control of rinse flows, etc. in metal finishing, and construction of recirculating systems for general cooling.

COST METHODOLOGY

A detailed procedure was developed for estimating the cost of facilities requied for each treatment alternative. Cost models were selected which were specifically derived from industrial cost information whenever possible. Alternative sources were evaluated and the most reliable cost models selected for use in this analysis. In some cases equipment manufacturers were conducted to obtain costs for processes not available from other sources.

Using unit cost information costs of the design example facilities were estimated. These costs were in turn used as the basis for estimating industry-wide costs. Capital costs were estimated for different size plants

by apportioning construction costs on the basis of plant capacities raised to the 0.6 power; operation and maintenance costs were estimated in a similar fashion using a ratio of plant capacities raised to the 0.85 power. Costs for the disposal of sludges and brines were estimated as separate items.

Cost estimates were reduced to a present worth basis for comparative purposes. Total costs for 5 3/8, 7, and 10 percent were calculated. Original capital costs, replacement of capital as required, and annual operation and maintenance costs were included in the estimates. Additional details of the costing procedure are contained in the Phase II report.

The cost of treatment in municipal systems which would be borne by industrial and domestic users was estimated by allocating costs based on flow, BOD, suspended solids, nitrogen, and phosphorus loadings contributed by individual users. Cost allocations were prepared for each of the three final alternative plans. The methodology developed for this analysis presented in the Phase III report could be used to derive user change relationships for specific systems as they develop.

COMPARISON OF ALTERNATIVES

Treatment costs estimated for each industry were combined with sludge and brine disposal costs to give total project costs for each treatment alternative. Original capital and annual operational costs for each alternative are summarized in Table V by major industrial categories. These costs do not include costs for transporting sludges and brines away from the industry for final disposal. A summary of total treatment costs for each treatment alternative is presented in Table VI. These include the transport of brines to deep well injection sites for disposal. An alternate plan discussed in the Phase II report included evaporation of brines to dryness with subsequent transport to a suitable disposal site. For Alternative 3 it was estimated that 2,200,000 gal of brine containing 460,000 lb of solids would be produced each day. Because of the great expense involved in removing total dissolved solids from wastes and in properly disposing of the residues, the environmental impact of reducing total dissolved solids loads in the Cleveland-Akron area should be closely examined before these standards are implemented.

Likewise, there appears to be no feasible methods for the recovery of metals from mixed sludges at the present time. Land disposal may result in the return of metals to waterways. Thus the net effect of requiring removal of metals without adequate handling of the sludges produced will result only in transferring the problem from one location to another. While some metals may be reclaimed for reuse, the sludge

TABLE V

SUMMARY OF COSTS FOR ON-SITE TREATMENT

OF INDUSTRIAL WASTES

Treatment Alternative	Treatment Cost[a]							
	Chemical Industry		Rubber Products		Steel Production		Metal Working & Refining	
	Capital	O & M	Capital	O & M	Capital	O & M	Capital	O & M
1	2.9	0.4	4.9	0.8	101.4	10.6	95.9	11.1
2	7.0	1.0	9.6	1.6	117.2	13.4	112.9	12.8
3.	7.0	1.0	9.6	1.6	128.4	14.4	137.0	16.3
4	7.0	1.0	9.6	1.6	128.4	14.4	153.6	18.1
5	0.6	0.2	2.9	0.6	128.4	14.4	21.6	4.7

[a]Capital cost is given in $1,000,000; O & M cost is expressed as $1,000,000/yr. Costs do not include allowances for final disposal of sludges and brines.

TABLE VI

TOTAL COSTS FOR ON-SITE TREATMENT

OF INDUSTRIAL WASTES

Treatment Alternative	7% Present Worth Cost[a]
1	571
2	990
3	1,290
4	1,245
5	480

[a]Costs are for deep well injection of brine solutions and are expressed as $1,000,000.

disposal problem should be examined in greater detail.

Additional data required for the evaluation of treatment alternatives includes the resources required for each level of treatment. Chemical power and labor requirements for each treatment alternative are summarized in Table VII. Chemical requirements are very difficult to estimate without actual testing of individual wastestreams and should be regarded as general estimates only. Likewise, adequate information for precise estimates of electrical power and labor requirements were not available. Chemical requirements were estimated only for Alternative 2. Estimates for individual chemicals are given in the Phase II report.

Costs allocated for the treatment of industrial wastes in municipal systems are summarized in Table VIII. Plans A, B, and C refer to the final wastewater management plans developed by the municipal treatment and plan formulation contractors. A description of these plans is contained in the Phase III report. Cost allocations were based on treatment systems which would be in use in 1977 for water-based systems and in 1983 for land treatment systems. Details are presented in the Phase III report.

TABLE VII

POWER, LABOR, AND CHEMICAL REQUIREMENTS

FOR INDUSTRIAL WASTE TREATMENT

Treatment Alternative	Power (Mw)	Labor[a] (F.T.J.E.)[b]	Chemicals[c] (tn/day)
1	22	800	-
2	40	860	295
3	52	910	-
4	52	860	-
5	31	700	-

[a]Values do not include labor required for transport of sludges and brines.

[b]Full Time Job Equivalents.

[c]Estimate available only for Alternative 2.

TABLE VIII

ALLOCATION OF TREATMENT COSTS

IN COMBINED MUNICIPAL SYSTEMS

Plan	Capital Cost ($ X 10^{-6})		O & M Cost ($/yr X 10^{-6})	
	Industrial	Domestic	Industrial	Domestic
A	110	350	11	25
B	113	356	11	24
C	187	624	5	16

ALTERNATIVES FOR MANAGING WASTEWATER IN THE THREE RIVERS WATERSHED AREA

INDUSTRIAL WASTE STUDY

PHASE II - DESIGN AND COST OF INDUSTRIAL WASTEWATER TREATMENT SYSTEMS

Submitted to

Buffalo District, U. S. Army Corps of Engineers

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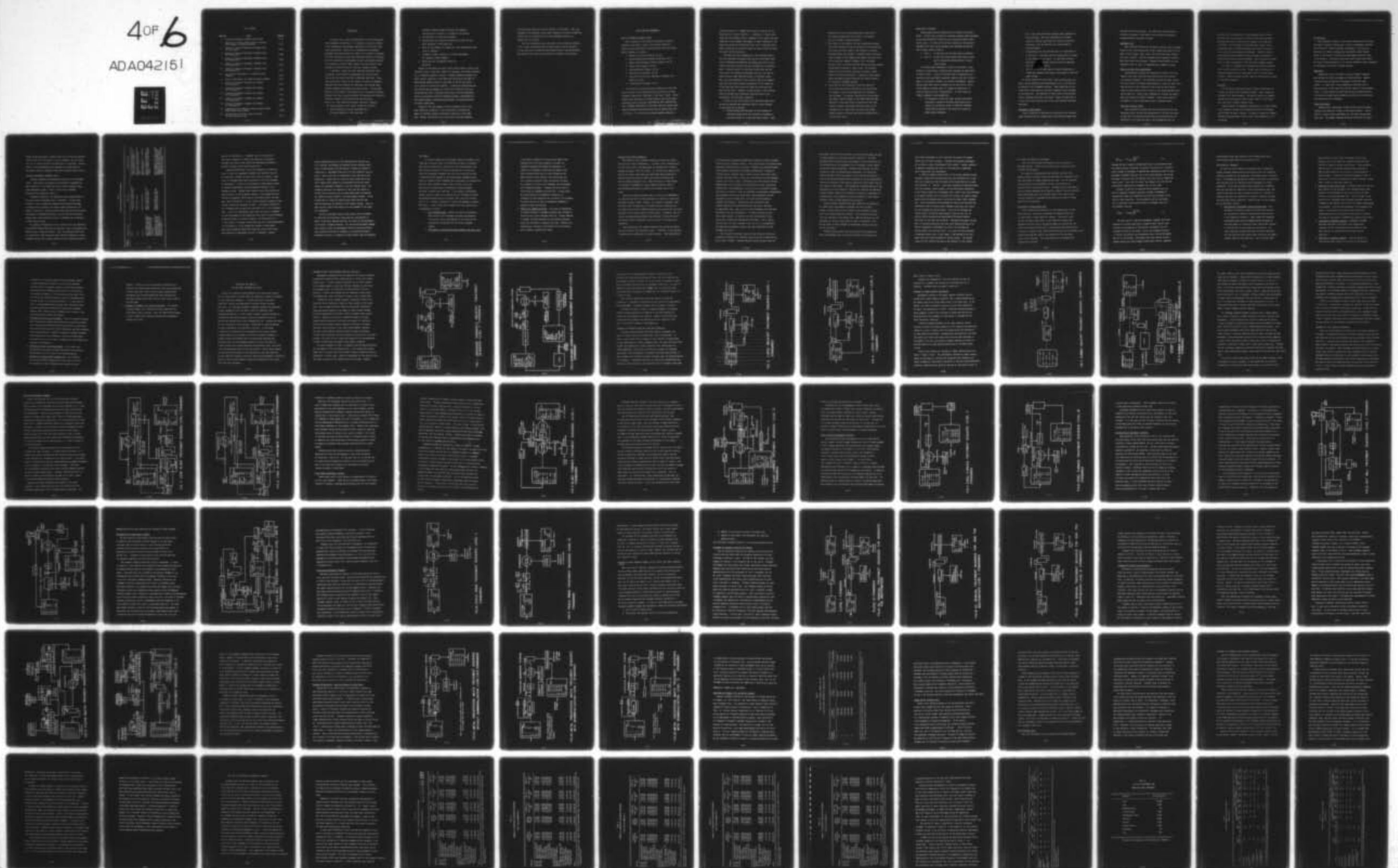

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INTRODUCTION

In order to fully assess the desirability of the various wastewater management alternatives, it is necessary to have an estimate of the technological and economic feasibility of the various plans under consideration. Major costs of implementing a wastewater management plan borne directly by industry will consist of treatment facilities required for waste to be discharged directly to waterways, facilities required for pretreatment of waste constituents required for discharge to municipal sewer systems, and the charges for the treatment of industrial waste in municipal treatment systems.

In the Phase I report the total industrial wastewater loads originating in the Three Rivers Watershed area for the present time and for the future from 1990 to 2020 were identified. These loads were used as a basis for the design of industrial wastewater treatment facilities required for compliance with proposed state effluent standards and federal water quality goals. The principal objective of this Phase II investigation was to conceptually develop treatment facilities and cost estimates for representative industrial categories located in the Study Area and to extend these costs to all firms comprising the major industrial categories.

The items contained in this report include the following:

1. Design sequences for plants representative of the major industries in the Study Area. A

treatment sequence diagram and discussion regarding the selection of processes is included for each design.

2. Cost estimates for each design sequence.
3. Industry-wide cost estimates concerning all plants for the major industries in the Study Area.
4. Costs for the disposal of sludges and brines generated for each level of treatment.
5. Estimates of power, chemicals, and labor requirements for industrial waste treatment.
6. Design and cost of combined industrial t[illegible]t facilities.

Because it was beyond the scope of this study to make a survey of the individual plants in the major industrial categories, the designs presented are, of necessity, general in nature. Although treatment processes presently used by industries in the Study Area were used as the basis of these designs whenever possible, they might not be the ones chosen by all plants of a particular industry. It should be stressed that the most feasible design sequence for a particular industrial plant can be selected only after a detailed plant survey of existing wastewater sources and presently available treatment processes, consideration of anticipated changes in manufacturing processes, and characterization of process wastestreams.

Because of the large number of plants included in most of the major industrial categories, it was not possible to evaluate the degree of treatment presently provided by industries in the Study Area. However, the capital cost of these facilities when compared

with the present worth cost for all industry is quite small. Thus, the treatment costs presented in this report represent the capital expenditure required for the construction of all unit treatment processes at January 1972 price levels.

Unit cost information used as the basis of cost estimates contained in this report was obtained from the most reliable sources available. In some cases price information was obtained directly from manufacturers. The sources of this data are discussed for individual unit processes.

DESIGN AND COST METHODOLOGY

SCOPE OF TREATMENT SEQUENCE DESIGNS

After evaluation of the industrial wastewater inventory contained in the Phase I report, the following industrial categories were identified as the major waste flows which would require treatment by industry:

1. Chemicals and Allied Products, SIC 28.
2. Petroleum Refining and Related Industries, SIC 29.
3. Rubber and Miscellaneous Plastic Products, SIC 30.
4. Primary Metal Products, SIC 33.
5. Fabricated Metal Products, SIC 34.
6. Non-Electrical Machinery, SIC 35.
7. Electrical and Electronic Machinery, Equipment, and Supplies, SIC 36.
8. Transportation Equipment, SIC 37.

The selection of wastes from major industries in the Study Area to be used in the treatment designs was based on average wastewater compositions identified in the Phase I report. Design examples were developed to provide effluents which would comply with water quality objectives specified for this investigation. Thus, although examination of individual industrial wastes might reveal additional constituents which must be removed from some wastestreams, it is felt that the design examples provide an

accurate appraisal of treatment which would be required for the major portion of these industries. In addition, it should recognized that the treatment design presented in this report have been addressed to the treatment requirements of major industries in the Study Area and do not include provisions for all industries which would be required to treat their wastes in order to meet the specified water quality objectives.

The major point to be emphasized is that treatment designs and costs developed from generalized data will more often suffer from an inadequate consideration of problems particular to each industry than from including too much treatment for a particular waste. Problems specific to individual plants which may add significantly to treatment requirements and costs can often be identified only after detailed surveys of individual plants. Thus, the costs developed in this study may tend to be somewhat lower than those which would be encountered if all industries in the Study Area were required to comply with the specified water quality goals. However, the deficiencies in this estimate could be overcome only by detailed characterization of the wastewtreams from individual industries.

In order to more fully identify the conditions under which the design sequences were developed, specific items included in the designs are as follows:

1. Process designs were developed for the treatment of waterborne wastes which are customarily discharged to receiving streams or to municipal sewer systems. Waste

substances such as oils and spent pickle liquors which are presently hauled away for disposal or reclamation were not included in design sequences.

2. The removal of constituents from very concentrated streams which have traditionally been associated with the manufacturing process and which result in the recovery of reusable by-products were not included in treatment designs and costs. Items included in this category were ammonia and phenol from coking operations removed in ammonia stills and phenol stripping units, flue dust from steel-making processes normally recovered and processed in sinter plants, and treatment required for recirculation of coolant solutions in metal forming and machining processes. Treatment of these wastes beyond the degree normally practiced for product recovery was included in treatment designs.

3. Provisions for the relocation of existing industrial facilities which might be required for the construction of treatment processing equipment were not included in cost estimates. In addition, provisions for piping above the nominal amount included in cost models were not made. Additional piping which might be required for the transmission of wastes from several processing areas to one treatment site in large plants and piping and process changes necessary for water reuse must be considered on a plant-by-plant basis.

WATER QUALITY CRITERIA

Proposed water quality standards were discussed in the Phase I report. Criteria were outlined for standards presently being developed by the Ohio Department of Health and for anticipated federal water quality goals. In order to relate these standards to the design of treatment facilities, design sequences were developed to meet two sets of water quality criteria:

1. Level I - to meet State of Ohio water quality standards.
2. Level II - to meet anticipated federal water quality goals and to incorporate maximum feasible in-plant reuse of water.

In relating these standards to industrial discharges, it was necessary to make several interpretations regarding the application of these criteria. Insofar as possible these interpretations are ones which state and federal regulatory agencies seem most likely to apply if the proposed standards are actually implemented. However, because these water quality standards are not yet official policy of the agencies involved, there is a degree of subjectivity in applying these particular interpretations. For both state and federal standards it was assumed that:

1. For discharges to municipal sewer systems constituents contained in industrial effluents which would not be reduced to satisfactory levels in municipal treatment plants must be reduced by the industry to conform to water quality standards.

This is the intent with which proposed state standards are being developed. While the interpretation of federal industrial effluent guidelines with respect to municipal discharges is not yet definite, this same approach is being considered.

2. A wastestream from one processing area of a plant which is in violation of the water quality standard must be treated by the industry at that point. In other words dilution with other process streams cannot be used for compliance with water quality criteria.

3. The criteria which would apply to a point discharge on a stream were assumed to also apply to discharges to municipal sewer systems.

As further definition of the Level I and II water quality criteria, various guidelines were established to aid in the selection and design of unit treatment processes. These guidelines are outlined below as they relate to the major industrial wastes produced in the Study Area. The relaxation of some criteria from the water quality standards discussed in the Phase I report was made only to a level which would allow the use of the best presently available technology.

Biochemical Oxygen Demand

State limitations on BOD which vary according to the volume of waste discharged and the intended uses of the receiving water were

followed for direct discharges. The federal goal was modified to allow the discharge of 5 mg/l BOD or that attainable by advanced treatment methods including filtration.

Suspended Solids

State standards allowing the discharge of 30 mg/l inert suspended solids to free flowing warm water fishery streams and 20 mg/l to cold water fishery streams, senic rivers, and inland lakes were followed for Level I designs. Volatile suspended solids standards included in BOD criteria were also followed. Allowable concentrations of total suspended solids for Level II standards were increased to 5 mg/l.

Metals and Other Toxic Constituents

Concentrations of metals were modified to conform to the best removals attainable using one-stage precipitation and filtration or equivalent treatment. For discharges to municipal sewer systems this would result in effluent concentrations to receiving waters lower than the State of Ohio standards in most cases and would greatly reduce the mass emission rate of metals to the three watershed areas and to Lake Erie. State of Ohio standards for cyanides and phenols were also adopted for federal standards. These values should be achievable in a well maintained biological treatment system.

Dissolved Inorganic Solids

State standards stipulate that the net dissolved solids load discharged cannot increase the concentration in the receiving water by more than five percent provided that the dissolved solids concentration in the receiving water is not exceeded and that the

dissolved solids concentration in the discharge does not exceed five times the dissolved solids criteria for the receiving water. The dissolved solids criteria for all streams in the Study Area is 500 mg/l. For discharges to municipal sewer systems, it was assumed that total dissolved inorganic solids would be limited to five times the stream standard or 2,500 mg/l. Smaller limiting concentrations were applied to direct discharges to waterways in areas receiving several waste discharges. Specific mention of these cases is made in discussions of the individual treatment schemes.

For Level II standards all discharges were limited to 500 mg/l total dissolved inorganic solids. In most cases the necessity of treating wastewater to this level would result in in-plant reuse of water. Factors relating to water reuse are discussed with respect to individual industries.

Nutrients

For the State of Ohio water quality criteria limitations for nitrogen are applied only to ammonia-nitrogen. These values were followed in all design examples. For Level II designs the federal standards were modified to allow effluent values of 1 mg/l NH_3-N and 5 mg/l total kjeldahl nitrogen (TKN).

State standards for phosphorus allowing 0.5 or 1.0 mg/l average total phosphorus concentrations depending on the flow discharged were followed for Level I designs. For Level II designs the federal standards were modified to allow 0.5 mg/l total phosphorus in all discharges.

Oil and Grease

State standards limiting oil and grease concentrations to 10 mg/l and federal standards allowing only a "trace" in wastewater effluents were followed for direct discharges to waterways. The trace concentration for federal standards was interpreted to mean effluent values in the range of 5-10 mg/l, since measurement below this value is not accurate. Discharges to municipal sewer systems were limited to 50 mg/l since this quantity of oil could be reduced to levels acceptable for discharge in biological treatment systems.

Temperature

Temperature criteria included in state and federal standards were followed for direct discharges to receiving waters. However, limitations were not applied to discharges to municipal sewer systems. In these cases it was assumed that sufficient loss of heat would occur in the sewer line from the industry to the treatment plant. In some instances for which the municipal effluent would be in violation of water quality standards, cooling of the entire waste flow would have to be considered.

Other Constituents

Numerous other constituents included in both state and federal standards were generally followed in the design examples. Specific mention is made of these constituents for individual designs where applicable. The federal standards contained limitations on several

common cations and anions. Because of the lack of feasible treatment methods specific for the removal of these compounds, specific treatment for the removal of these substances was not considered. However, removal of these substances would frequently be accomplished to satisfactory levels in complying with total dissolved solids criteria.

INDUSTRIAL WASTEWATER TREATMENT LEVELS

Treatment sequences were designed and costed for five treatment levels. These designs included on-site treatment of wastewater by major industries in the Study Area for the various regional wastewater management systems. Details of the various treatment alternatives are compared to Table I.

Treatment Alternative 1 was designed to meet proposed State of Ohio Water Quality Standards (Level I treatment). To meet these standards, it was assumed that industries would reduce discharges to combined sewer systems by the nominal amounts discussed in the chapter of the Phase I report entitled "Future Industrial Waste Loads." The purpose of Treatment Alternative 2 was to meet the anticipated federal water qulity objectives (Level II treatment) and to maximize in-plant reuse of water.

The purpose of Alternative 3 was to estimate costs for compliance with proposed federal water quality objectives (Level II) assuming only nominal reuse of water by industry. Thus, the wastewater flows used for Alternative 3 were the same as those used for Alternative 1 waste treatment designs, while process designs for this alternative were the

TABLE I

INDUSTRIAL WASTEWATER TREATMENT ALTERNATIVES

Treatment Alternative	Treatment Criteria	Waste Flows	Treatment Facilities
1	Level I	Present flows with nominal reductions in water use for projected flows.	Details of individual treatment facilities given in "Design and Cost Analysis for Individual Treatment Facilities."
2	Level II	Maximum reuse of water.	Details given in "Design and Cost Analysis for Individual Treatment Facilities" chapter.
3	Level II	Same as for Alternative 1.	Same as for Alternative 2, but same flows used for Alternative 1.
4	Level II modified to not require removal of heavy metals except where necessary to meet other treatment objectives or where waste is discharged directly to waterways.	Same as Alternative 1 except that all flows but those from steel mills treated in municipal systems.	Same as for Alternative 3 except for changes in treatment of wastes from metal finishing industries not requiring demineralization.
5	Level II modified to not require demineralization or removal of heavy metals except for direct discharge to waterways or where metals would interfere with biological treatment.	Same as Alternative 4; biological treatment of combined wastes from shoreline area in one system.	Same as Alternative 3 for steel mill wastes; same as Alternative 1 for rubber industry and for wastes containing moderate TDS concentrations requiring oil removal; treatment for other industries discussed in "Design and Cost Analysis for Individual Treatment Facilities" chapter.

same as for Alternative 2. Treatment costs for Alternative 2 and 3 may be compared to indicate the reduction of wastewater treatment costs which would result from implementing maximum reductions in water use and recycling practices.

Treatment Alternatives 4 and 5 were designed to estimate the costs of industrial wastewater treatment which would be incurred by industries if removal of heavy metals were not required. These levels of treatment would apply principally to the land treatment of wastewaters if it were to be concluded that heavy metals present in industrial wastewaters could be adequately handled in land treatment systems. Because these treatment levels were designed to apply primarily to land treatment systems, it was assumed that most industrial wastewaters which would be discharged directly to waterways under Alternatives 1, 2, and 3 would instead be treated in land disposal systems for Alternative 4 and 5. The notable exception to this assumption was the waste flow from steel mills in the Cleveland area. In all five alternatives, provisions were made for treatment of these wastewaters by the respective steel industries with subsequent discharge directly to receiving streams. For Alternatives 2, 3, 4, and 5 Level II treatment criteria were applied to these wastestreams. For Alternative 4, it was assumed that removal of heavy metals would not be required except where necessary to meet other treatment objectives as designated in Level II standards. However,

because demineralization to a TDS concentration of 500 mg/l was still required, pretreatment for demineralization processes would result in approximately the same removal of metals as achieved in Alternative 3. Wastewater from steel mills was treated to Level II levels. Waste flows used for Alternative 4 were the same as for Alternative 1 except that all flows but those originating in the steel industry were assumed to be discharged to municipal sewer systems for subsequent treatment in the land disposal areas. The treatment objectives for Alternative 5 were that the removal of neither total dissolved solids nor heavy metals would be required for industrial wastes treated in the land disposal systems. It was assumed that all industrial wastes except those from the steel industry would again be treated in land disposal systems. Level II water quality criteria were applied for the treatment of the steel mill wastewaters.

The only requirement placed on heavy metals loads discharged by industries for Alternative 5 were that the concentration of metals in the total combined municipal flow would not be detrimental to biological treatment processes. For region-wide wastewater management systems in which raw wastewaters from the Cleveland and Akron areas would be collected for treatment in centralized biological treatment facilities, no reduction of heavy metals loads was necessary.

COST MODELS

The general objective of the economic analysis included in this study was to provide a basis for evaluating the impact of proposed water quality objectives on industries in the Cleveland-Akron area, and to provide a means for directly comparing costs incurred for industrial wastewater treatment with costs which would be incurred in developing other aspects of various wastewater management plans. Costs for industrial waste treatment were calculated on a present worth basis for three different interest rates in order to test the sensitivity of system design to alternative financing methods. The three interest rates used were: 1) the January, 1972 federal interest rate of 5 3/8%, 2) an interest rate of 7% chosen to reflect the average borrowing rate as of January, 1972, and 3) an interest rate of 10%. Insofar as possible, all costs were adjusted to January, 1972 levels. Factors which were included in the cost analysis may be enumerated as follows:

1. Unit treatment costs. Capital and operation and maintenance costs for unit treatment processes were obtained from various sources and combined to give costs for the construction and operation of the various treatment systems.
2. Contingency, engineering and administration, and misc. costs.

A contingency allowance of 20 percent was added to the combined cost of all unit processes to account for unexpected expenses which might be encountered. In addition, an allowance of 20 percent was added to the total estimated design cost to cover engineering and administration of the contract, land acquisition, and misc. expenses related to plant construction including an allowance for piping to the treatment unit and between unit treatment processes. Although land to be used for the location of treatment facilities will, in many cases, be already owned by the respective industries, an allowance for land acquisition was included in all estimates to reflect the use of land for wastewater treatment as opposed to other applications.

3. Handling of sludges and brines. Provisions for dewatering of sludges produced in treatment processes were included in the basic cost of each treatment facility. Further handling of sludges including transport to centralized collection points was included as a separate cost item. Likewise, the concentration, transport, and disposal of brine solutions were included as separate cost items.

Sources of Unit Cost Information

Cost models for unit treatment processes obtained from several sources are included in Attachment A. Included in this attachment are all cost curves used in the development of treatment cost estimates updated to January, 1972 price levels. In selecting cost models to be used in this study, comparisons were made among models presented in several sources and the most recent and accurate information was used to estimate treatment costs. While the details of these models are included in Attachment A, special mention should be made of cost estimates developed for several unit processes used in this study.

The cost of control buildings shown in Figure A-2 of Attachment A was compiled from data from the construction of municipal primary and secondary treatment plants. However, for industrial wastewater treatment facilities the necessity for providing control structures will vary with the particular treatment processes used and with the facilities available in the process areas of various plants. Therefore, costs for control structures were estimated using the data in Figure A-2 and by considering specific conditions likely to prevail in the particular industries.

Cost relationships for chromium reduction and cyanide destruction were not available from literature sources. Therefore, it was necessary to develop cost relationships for these processes. Three manufacturers

of plating wastes treatment equipment were contacted to obtain representative costs for treatment systems. Costs were obtained for systems having capacities ranging from 15 to 200 gpm. Estimates for package treatment units normally supplied by the equipment manufacturers included all instrumentation, treatment tanks, internal piping, installation costs assuming that pump piping, wiring, etc. were installed to the treatment location, and start-up costs. Additional costs were obtained from the manufacturers for the purchase and installation of level controllers, holding tanks, site preparation, wiring, piping, and chemical storage facilities as required. Costs for subsequent pH adjustment, sedimentation, and filtration required to remove metals from wastewaters were not included in costs for these units, but rather were estimated as separate unit processes. Because the costs obtained for both chromium reduction and cyanide destruction were nearly identical for equivalent flow rates, costs for these treatment units have been presented as one cost relationship. It should be noted that the cost of units having a capacity less than approximately 25 gpm varies only slightly with decreasing design flows. This is due to the fact that, for small treatment units, prices of instrumentation and chemical feed equipment comprise the major percentage of total treatment unit costs.

The stringent limitations placed on total dissolved solids concentrations acceptable for discharge required the use of demineralization in many instances. Because demineralization processes have not

been widely applied for this purpose, the relative performance and cost of these processes has not been precisely identified. The three demineralization processes which were judged to be most applicable for the demineralization of wastewaters are ion exchange, reverse osmosis, and multiple-effect evaporation. Although electrodialysis has been studied as a means of demineralizing wastewaters, this method was rejected because of the large number of cells required to produce a brine of the desired concentration and because of the few technological innovations presently in the research stage which could reduce costs of this process in the future. Ion exchange was considered because of the widespread use of this process in the past for softening and demineralization; however, because of the chemicals necessary to regenerate ion exchange resins, large amounts of brine are produced in this process compared to that of other demineralization methods.

Multiple-effect evaporation has been studied for the production of potable water from domestic wastewater and from sea water. However, the application of this process to the treatment of wastewater has not been extensively studied. Little operating data and costs are available at the present time. Measures necessary for the prevention of corrosion and buildup of scale in evaporation units and the effect of these problems on replacement and operating costs are not well known.

Although reverse osmosis has been applied to the treatment of water and wastewater only in the last few years, the prospects for

the further development of this relatively new process are perhaps better than for other processes. Problems with membrane performance are currently a major disadvantage of this process. However, advances in membrane technology may result in the production of membranes which require much less maintenance.

In order to compare relative costs of the various demineralization processes, construction and operating costs were estimated for a 1 mgd facility to reduce the total dissolved solids concentration of a waste from 2,500 mg/l to 500 mg/l. Costs were estimated for demineralization using ion exchange, reverse osmosis, and multiple-effect evaporation. To facilitiate comparison of estimated costs, capital costs were amortized at an annual interest rate of 7 percent for 20 years and added to annual operation and maintenance costs to arrive at an annual total treatment cost. While differences existed between the capital and operation and maintenance costs, the total annual treatment costs were very similar for ion exchange and reverse osmosis. Costs for ion exchange and reverse osmosis differed by approximately 6 percent; the cost for multiple-effect evporation was approximately 50 percent greater than costs for the other two processes. Considering the amount of data which is available concerning the large scale demineralization of industrial wastewaters, differences in costs of ion exchange and reverse osmosis are relatively small. As a basis for the estimation of demineralization costs in this study, it was decided to use cost models which have been developed for reverse osmosis. The primary reason for this selection was due to the potential of this process

for further technological development.

Costs for cooling towers were based on values reported for the power industry. These costs are based on wet, mechanical draft crossflow cooling towers.

As a means of concentrating brine solutions resulting from demineralization of wastes, costs were estimated for evaporation units. Costs were based on systems containing two loops - one for concentration of brines up to approximately 100 g/l, and the other for crystalization of the resulting salts. Although costs of evaporation units are highly dependent on the specific nature of the brine solution being concentrated, the cost estimates used in this study did not include allowances for equipment which would be resistant to highly corrosive brine solutions.

Estimation of Industry-Wide Costs

After compiling cost estimates for the example plants in each design sequence, costs were extrapolated to determine total cost to treat wastes in each industrial category. Construction costs for the different sized plants in each industrial category were estimated from the costs of the design example by applying the "0.6 factor" discussed by Chilton [3]. From analyzing construction costs for plants of various sizes, Chilton found that the cost of different sized plants varied with the ratio of the capacities of the two plants raised to the 0.6 power. This relationship may be mathematically represented as follows:

$$(\$_2)_{cap} = (\$_1)_{cap} \left(\frac{Q_2}{Q_1}\right)^{0.6} \quad (1)$$

Although Chilton's analysis related specifically to construction costs for chemical process industries, an analysis of capital cost relationships included in Attachment A revealed that construction costs for unit wastewater treatment processes used in this study generally vary as the 0.5 power of capacity ratio for smaller plants and as the 0.7 power for larger plants. Thus, the "0.6 factor" was judged to be valid for the estimation of industry-wide treatment costs in this study.

Likewise, an analysis of operation and maintenance costs for unit to wastewater treatment processes included in Attachment A revealed that these costs generally vary with the 0.85 power of the ratio of plant capacities. The relationship used for the estimation of operation and maintenance costs for treatment facilities of different sizes was:

$$(\$_2)_{OM} = (\$_1)_{OM} \left(\frac{Q_2}{Q_1}\right)^{0.85} \quad (2)$$

The total cost for industrial wastewater treatment facilities computed on a present worth basis included original capital costs incurred at the beginning of the project, replacement costs for equipment incurred as the useful life of unit treatment processes is reached, and operation and maintenance costs incurred throughout the life of the project. Replacement costs were reduced to their present worth using single payment present worth factors; operation

and maintenance costs were reduced to their present worth using series present worth factors for a period of 50 yr.

DESIGN AND COST PROCEDURE

In order to clearly identify the procedure used in developing example treatment sequence designs and the total costs for industrial wastewater treatment in the Study Area, the procedure used is outlined below. The methodology employed was intended to be used in establishing and projecting costs for industries having wastewaters of similar composition. While these procedures were developed for information which was available for industries in the Cleveland-Akron area, they should be applicable to other situations in which it is desired to determine the total cost required for a group of industries to attain specified water quality objectives. Specific steps of this procedure may be outlined as follows:

1. Re-evaluation of Wastewater Characterization Data. Data presented in the Phase I report for 4-digit SIC categories was reviewed with respect to manufacturing processes used in the respective industries. Major industrial categories whose wastes would require treatment before discharge to receiving waters or to municipal sewer systems were selected to form the basis of the design and cost analysis. The major industries selected were those from which compliance with the specified water quality goals would have the largest economic impact on the Study Area. Thus, selections were

based primarily on waste flows discharged by the various industries and on the degree of treatment required for each industry to comply with water quality goals. Characterization data for each of the selected industries was projected to 1990 and 2020 conditions for the use in the development of design examples. Projections for the achievement of Level II water quality criteria were modified to reflect maximum in-plant reuse of water by individual industries.

2. Selection of Plant Design Sizes. Estimated wastewater flows for each industrial plant included in the treatment designs were related to the employment for each firm listed in the 1969 Directory of Ohio Manufacturers [4]. Plants included in each four-digit SIC subcategory which produced wastewater requiring treatment by the industry were divided into several groups based on employment. From the total wastewater flow produced by the plants in each grouping, an average flow per plant was determined which was then applied to each plant in a particular group for the purpose of determining treatment plant costs.

3. Evaluation of Treatment Processes. Wastewater treatment processes applicable to the waste to be treated were evaluated in order to determine the most effective treatment processes for achieving the given water quality objectives.

4. Selection of Treatment Sequences. Processes chosen for final designs were selected on the basis of the volume of

wastewater to be treated, nature of the constituents present in each wastestream, reliability of the various treatment processes, cost of processes relative to equalivent processes, and possibilities afforded by each processs for the recovery of saleable by-products. For the purpose of this study, final process designs reflected insofar as possible, technology which has been proven in full-scale applications. If, upon examination, it was determined that the waste from a particular plant could be treated more economically by alternative treatment methods, total industrial waste treatment costs incurred in the Study Area would be reduced accordingly.

5. Selection of Unit Process Cost Models. Costs of treatment processes used in the design examples were obtained from currently available cost literature, from literature describing industrial waste treatment practices and costs for specific industries, and from contacting various manufacturers of industrial wastewater treatment equipment. After reviewing all cost information, the most reliable models were chosen for use in the study. Treatment cost relationships are discussed in Attachment A.

6. Estimation of Costs for Design Examples. Unit process cost relationships were used to estimate construction and operation and maintenance costs for each of the treatment designs.

7. Estimation of Industry-Wide Treatment Costs. The estimated cost for each example treatment design was used as the basis for projection of total treatment costs required for each

industry. Capital costs were estimated for different size industries by assuming that construction costs were proportional to plant capacities raised to the 0.6 power; operation and maintenance costs were estimated from costs calcualted for the design example plants and a ratio of plant sizes raised to the 0.85 power.

8. Disposal of Sludges, Oil, and Brine Solutions. The quantity of waste sludges, oils, and brine solutions resulting from each industry were calculated. Costs for handling and disposal of these sludges using alternative methods were estimated as separate cost items.

DESIGN AND COST ANALYSIS
FOR INDIVIDUAL TREATMENT FACILITIES

Analysis of industrial wastes produced in the Study Area revealed that the major portion of waste requiring treatment by industry originated in eight industrial categories. To treat waste waters from these industries, designs were developed for fourteen example treatment facilities. For each design example, treatment sequences were developed to meet treatment criteria for each of the five industrial waste treatment alternatives. In this chapter treatment sequence diagrams are presented for each design example along with estimated cost for the construction and operation of each treatment facility. Diagrams are shown only for Alternative 1 and 2 designs. Differences in these and designs for other alternatives are mentioned in the text. To facilitate a comparison of effluent qualities produced for the various systems, treatment designs are presented in the form of schematic diagrams including influent and effluent flows and constituent concentrations. Estimated costs for each treatment sequence are shown including the original capital cost, annual operation and maintenance costs, the useful life, and replacement costs for each unit process. While process designs and cost analyses were made to be as applicable to the many industries in each industrial category as possible, designs were developed in sufficient detail so that all major elements required for operation of the various facilities were considered.

TREATMENT OF WASTE FROM INORGANIC CHEMICALS INDUSTRIES

Wastewaters originating from the production of inorganic chemicals surveyed were characterized by concentrations of various heavy metals ranging from 1 - 10 mg/l, moderate concentrations of other inorganic ions including ammonia- and nitrate-nitrogen, moderate concentrations of suspended solids, and relatively low concentrations of organic materials. Process flow diagrams for the treatment of these wastes for Alternatives 1 and 2 are shown in Figures 1 and 2, respectively.

Although the large inorganic chemical industries located in the Study Area do not discharge to municipal sewer systems at the present time, it was assumed that these industries would begin discharging pretreated process wastes to city sewers in order to meet nitrogen discharge requirements specified for State and Federal water quality criteria. Because nitrification of ammonia-nitrogen or nitrogen removal would be required of municipal waste waters for compliance with the specified water quality standards, discharge of inorganic chemicals industry wastes to city sewers would probably represent the least costly method of meeting effluent nitrogen requirements. Although large industries have been reluctant to discharge to city sewer systems in the past, this attitude might change with the implementation of more stringent State and Federal water quality standards.

For the achievement of Level II standards requiring demineralization for the removal of total dissolved solids, it was assumed that approximately 50% of the waste flow from inorganic chemical industries would be returned for in-plant reuse. Specific requirements for the quality of process water required by this industry were not available. However,

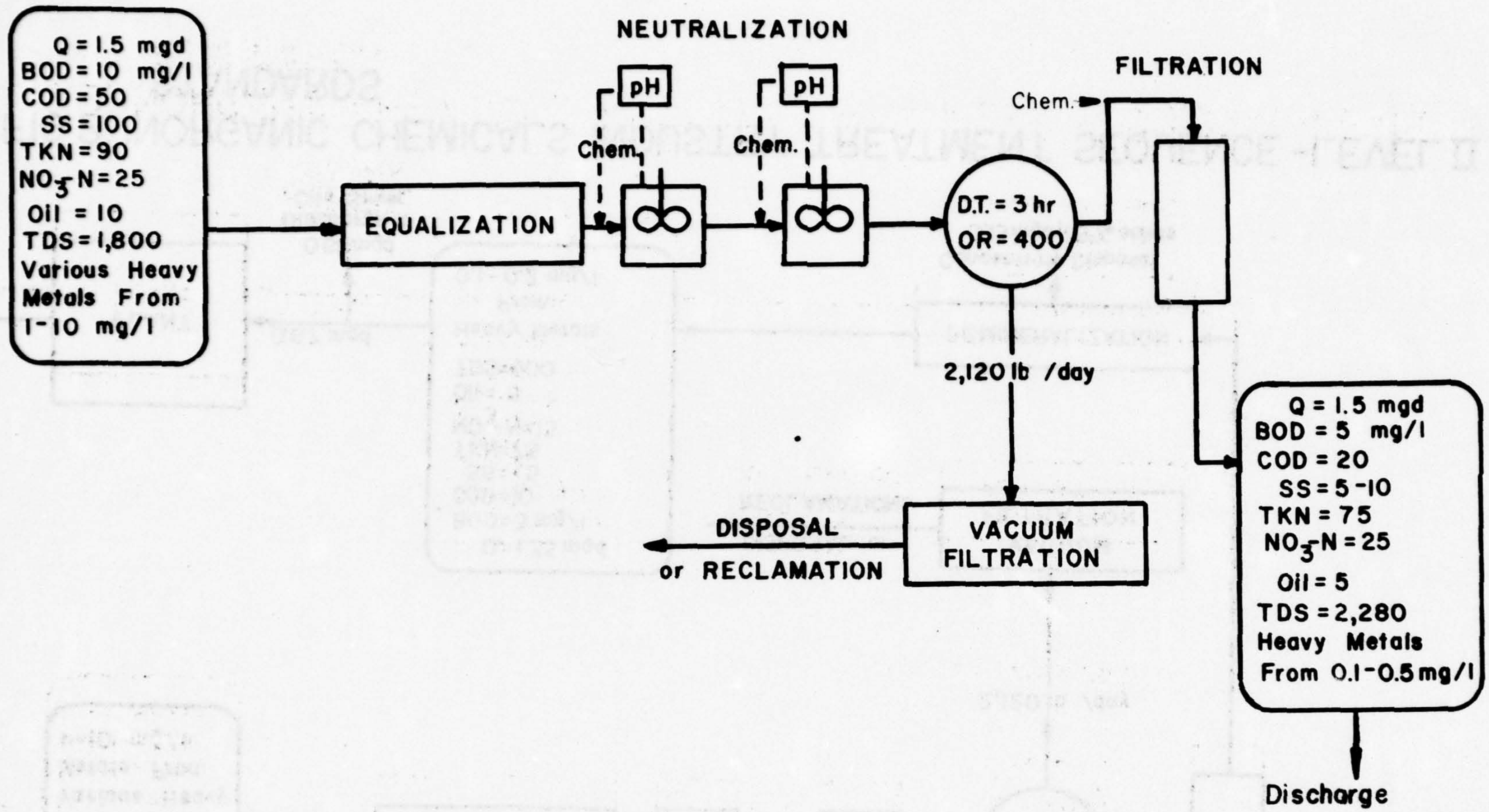

FIG. I . INORGANIC CHEMICALS INDUSTRY TREATMENT SEQUENCE-LEVEL I STANDARDS

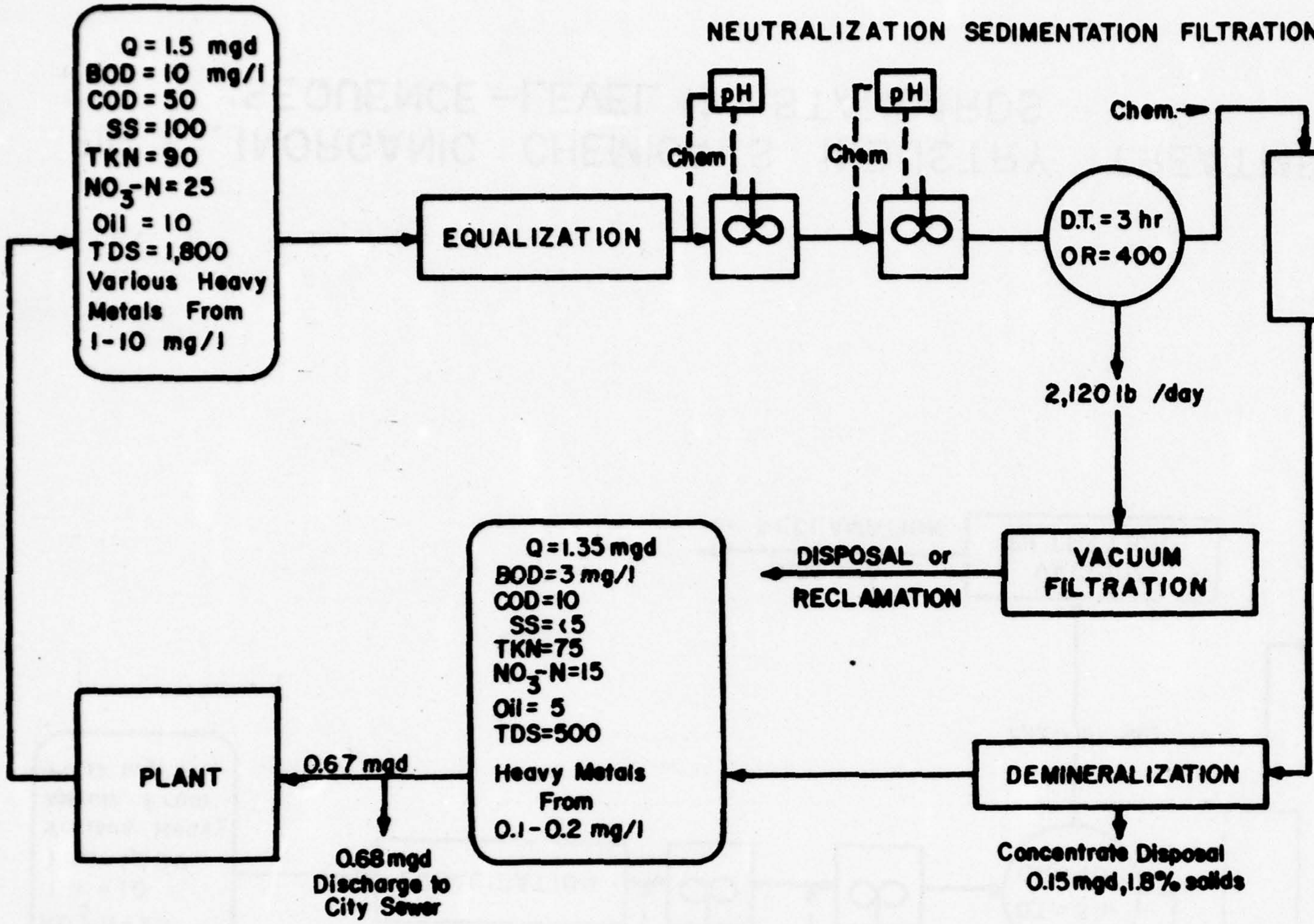

FIG. 2. INORGANIC CHEMICALS INDUSTRY TREATMENT SEQUENCE - LEVEL II STANDARDS

conversations with representatives of chemical industries in the Cleveland area indicated that wastewater reuse might be limited both by the buildup of certain inorganic ions as well as by fluctuations in water quality resulting from variations in wastewater composition. For Level II standards it was also assumed that blowdown from the industrial water system would be discharged to city sewers both for additional removal of nitrogen and BOD.

Treatment for Alternatives 3 and 4 was identical to that for Alternative 2; treatment for Alternative 5 consisted only of equalization and pH adjustment. Estimated treatment costs are shown in Table B-I.

As noted in the Phase I report, a complete inventory of inorganic chemcial industry wastes was not made due to the wide diversity of constituents discharged by this industry. However, plants which were inventoried and included in the design contribute a majority of the waste flow from this industry in the Study Area.

TREATMENT OF WASTEWATER RESULTING FROM LATEX PRODUCTION

Treatment schemes developed for latex industry wastewaters are shown in Figures 3 and 4 for Alternatives 1 and 2, respectively. As shown in these figures waste produced in this industry is characterized by high concentrations of BOD, suspended solids, and total dissolved solids. However, the composition of waste produced in this industry may vary widely depending on the specific use for which products are intended. Variations in the concentration of inorganic dissolved solids present in waste streams will significantly affect treatment costs for demineralization of wastewaters. Pretreatment might not be required for wastestreams from some latex plants containing lower concentrations of inorganic solids than

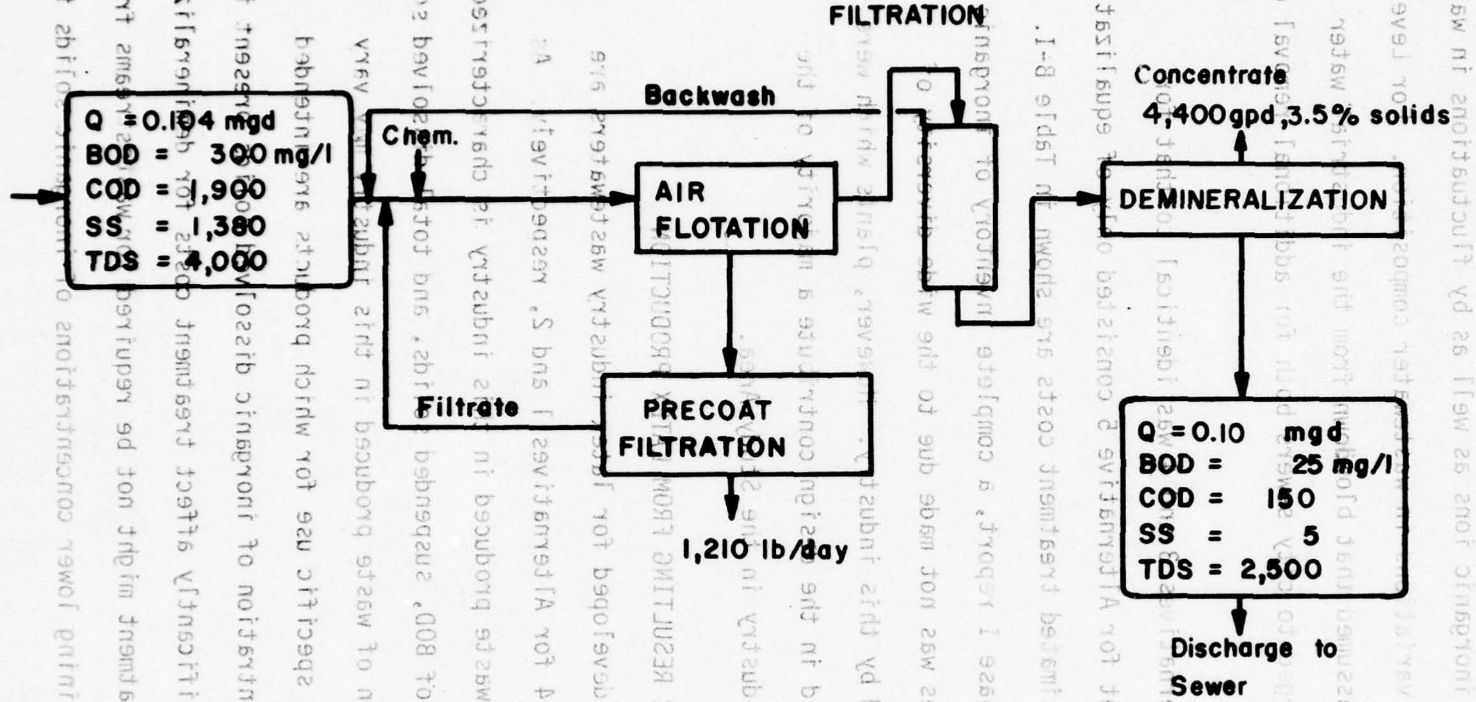

FIG. 3. LATEX INDUSTRY TREATMENT SEQUENCE - LEVEL I STANDARDS

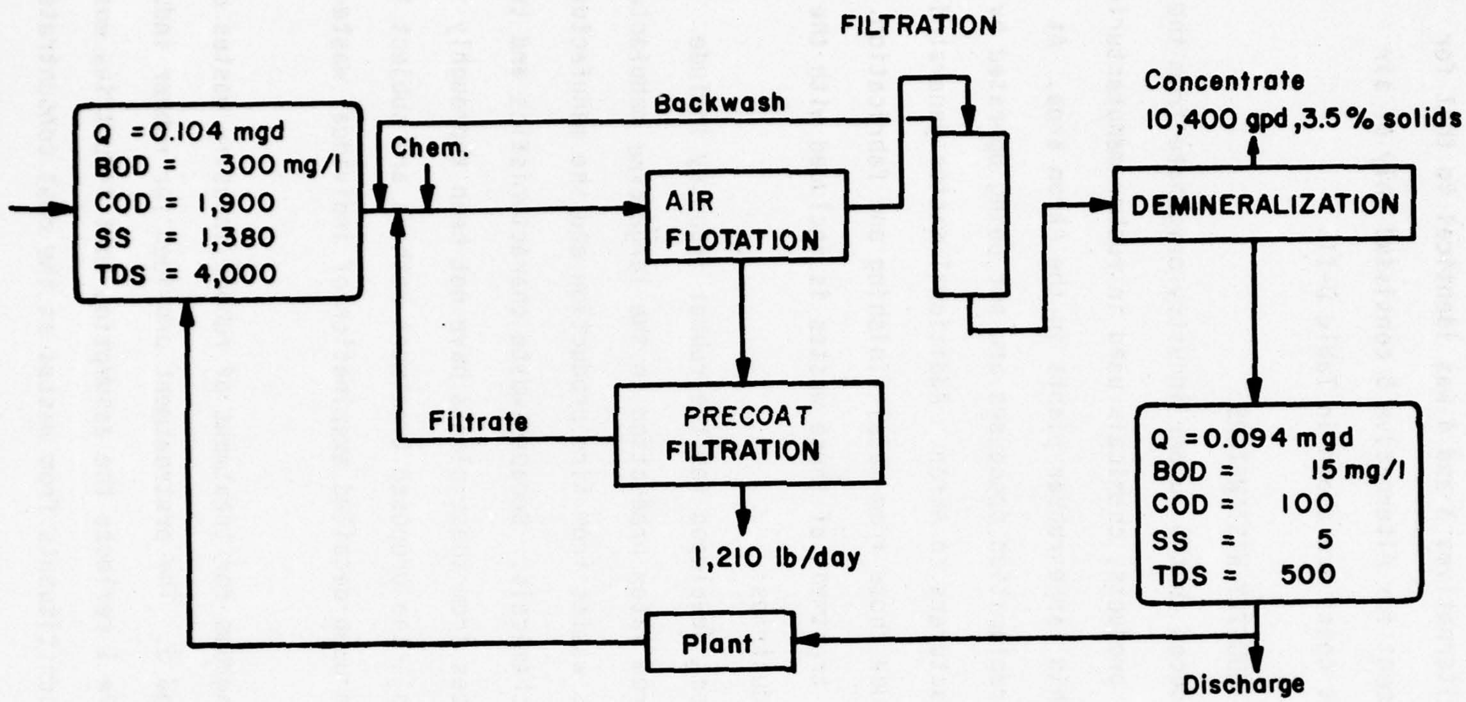

FIG. 4. LATEX INDUSTRY TREATMENT SEQUENCE - LEVEL II STANDARDS

those listed in Figures 3 and 4.

Treatment for Alternatives 3 and 4 was identical to that for Alternative 2; treatment for Alternative 5 consisted only of air flotation. Treatment costs are shown in Table B-II.

TREATMENT OF RUBBER INDUSTRY WASTEWATERS

Wastewaters produced in the rubber industry originate from the production of rubber products, chemicals used in rubber manufacturing, and rubber latex within large rubber plants in the Akron area. At the present time rubber reclamation processes are not being operated by the major tire manufacturers in Akron. Additional wastes generated by these companies include those from metal finishing and fabrication. Characterization and treatment of these wastes is included with the metal fabrication industries.

Treatment diagrams developed for the rubber industry include handling of wastes from latex production in the large tire manufacturing industries as well as wastes from tire production and the manufacture of some specialized chemicals. Because waste characteristics and treatment methods for wastes from these plants have not been thoroughly investigated in the past, the proposed treatment methods are subject to possible modification upon detailed examination of individual wastestreams.

Process flow diagrams for treatment of rubber industry wastes are shown in Figures 5 and 6. The pretreatment provided for rubber industry wastes for Alternative 1 reflects the assumption that industries must remove incompatible constituents from wastes at the most concentrated point. Therefore, demineralization would be required for some process wastes in

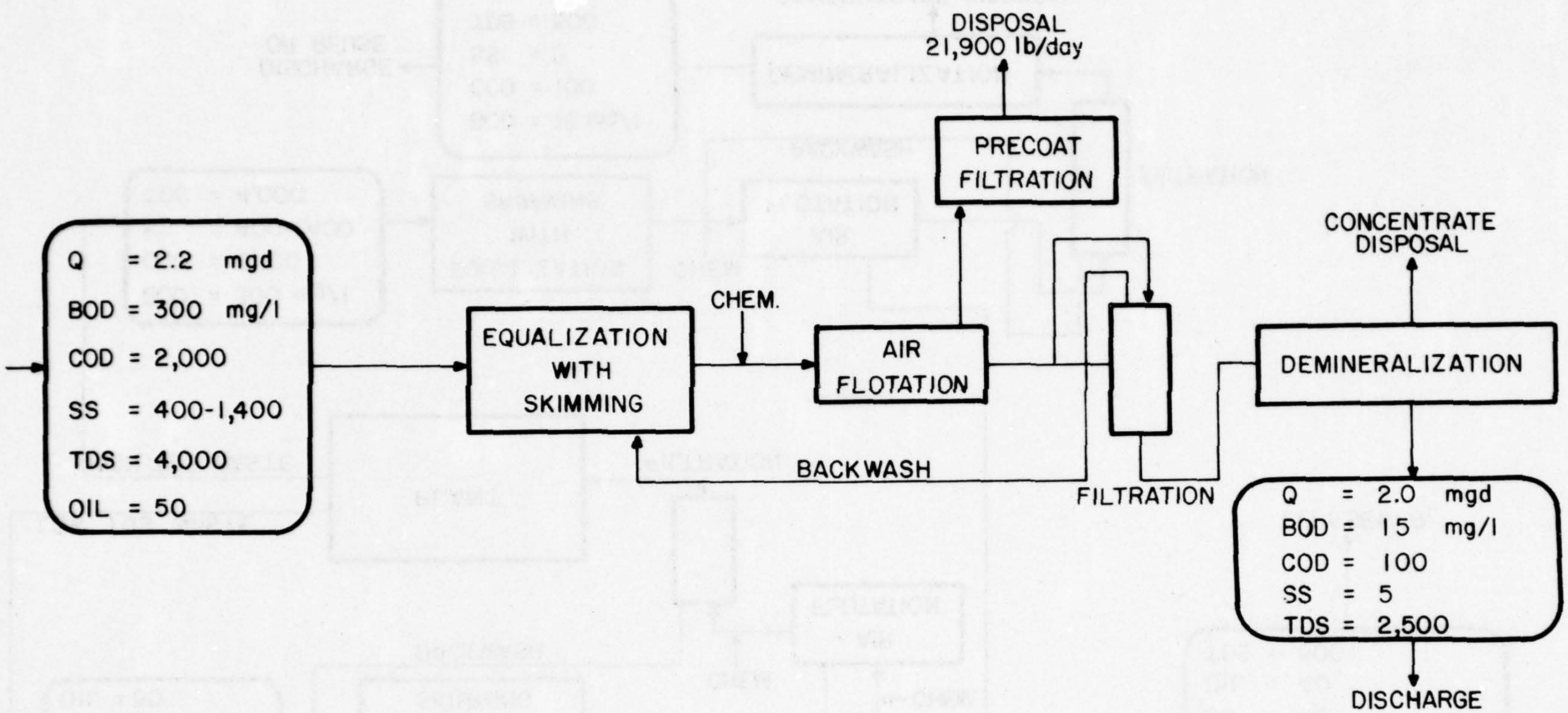

FIG. 5. RUBBER INDUSTRY TREATMENT SEQUENCE · LEVEL I STANDARDS

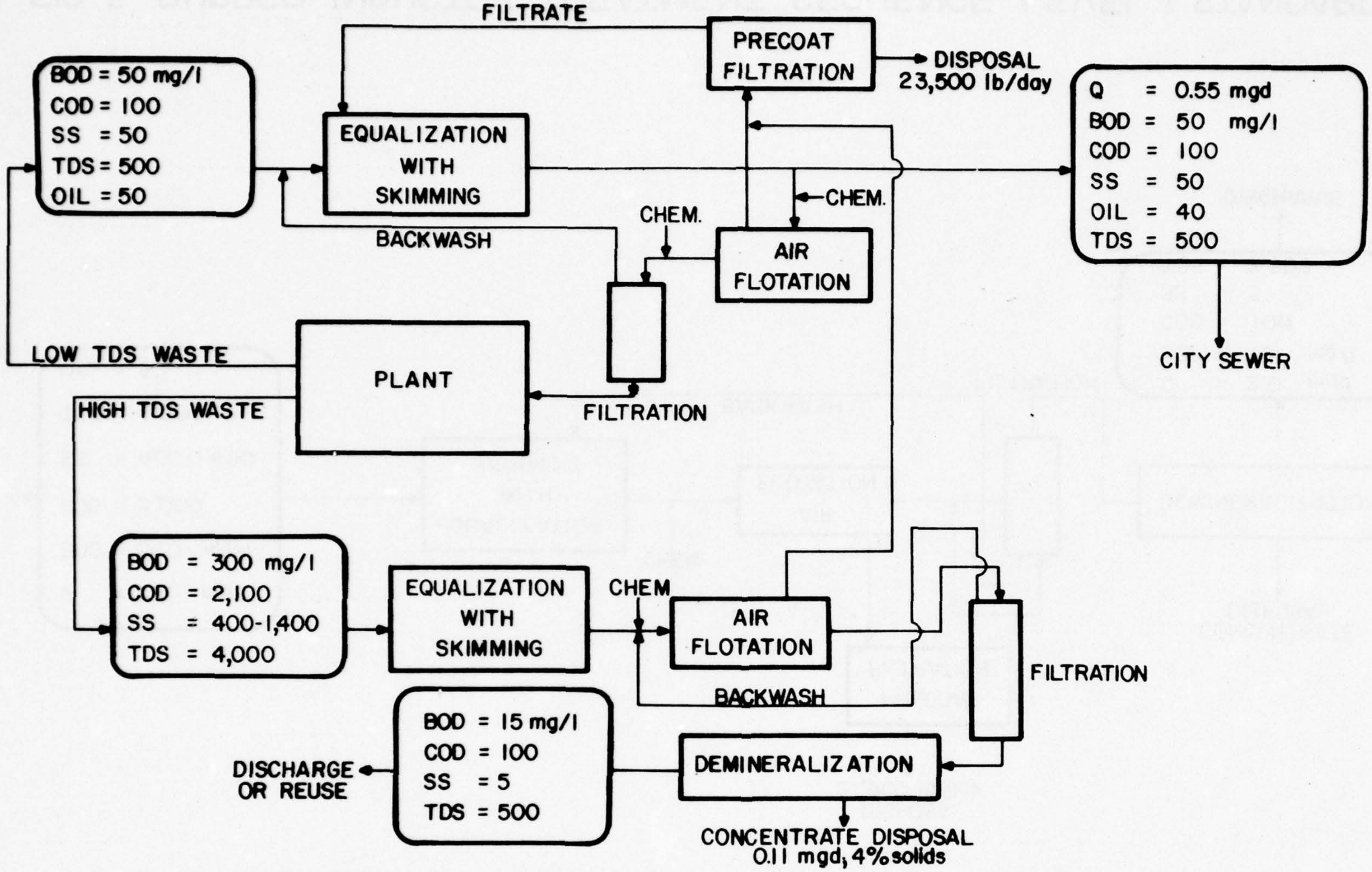

FIG. 6. RUBBER INDUSTRY TREATMENT SEQUENCE · LEVEL II STANDARDS

the rubber industry, while other wastestreams could be discharged to city sewers with no treatment. Wastes from the manufacture of rubber products might require treatment for removal of carbon black or oil, but it is anticipated that these constituents could be adequately controlled in-plant. If the total dissolved solids criteria were to be applied to the total process waste flow from the rubber industry, demineralization might not be required for Level I standards. Because complete characterizations of rubber industries wastewaters were not available, concentrations of total dissolved solids estimated for these wastes may be in error. If these wastes were found to contain additional constituents such as heavy metals, further treatment would be required.

The treatment sequence proposed to achieve Level II water quality goals, shown in Figure 6, includes provisions for partial reuse of plant wastewaters. Little information was available concerning the quality of water required for manufacturing processes and the potential for wastewater reuse within specific areas of rubber manufacturing plants. Likewise, because wastewater reuse has not been practiced in most of the rubber industry in the past, detailed plans for water reuse have not been developed. From conversations with officials of various rubber companies, it seems likely that partial reuse of water would result if industry were required to treat water to meet Level II water quality objectives. Although the EPA is presently conducting a detailed investigation regarding the treatment of rubber manufacturing wastes, results were not available for use in this study.

In order to reflect some reuse of water by the rubber industry in the achievement of Level II standards, it was assumed that this could be accomplished by dividing the plant wastestreams into low and high total

dissolved solids flows. Wastes containing high concentrations of total dissolved solids would be demineralized and returned for in-plant reuse, while streams containing lower concentrations of total dissolved solids would be discharged to city sewers. In estimating treatment costs it was assumed that it would be necessary to construct separate facilities for each wastestream. This treatment sequence is presented primarily to demonstrate the types of treatment processes required for compliance with Level II standards and to estimate costs associated with this level of treatment.

Costs for the treatment of rubber industry waste waters are shown in Table B-III. Alternative 5 treatment was identical to that for Alternative 1 except that demineralization was not required. Capital costs for precoat filtration obtained from manufacturers of this equipment showed that costs did not vary significantly from those for conventional vacuum filters. However, additional operation and maintenance costs were included for the purchase of extra chemicals necessary for this process.

TREATMENT OF STEEL INDUSTRY WASTEWATERS

Due to the large quantities of water used in the steel industry and the number of manufacturing processes involved, treatment process designs were developed for the major manufacturing areas included in the Cleveland steel mills. Separate process designs were made for coke production, blast furnaces, steel making furnaces, hot rolling mills, cold rolling mills, and pickle rinse waters. While treatment of waste originating in several process areas might be treated in a single treatment facility, separate treatment designs were developed for each production area because of the different products manufactured in each of the Cleveland mills and because the relative location of processing areas to each other varies from mill to mill. Process designs for each manufacturing area are considered separately below.

Coke Plant Wastewater Treatment

Because only one steel mill in the Cleveland area currently produces coke, waste loads reported in the previously published water quality reports of the Cleveland area and those reported in U. S. Corps of Engineers permit discharge applications were used to characterize this wastestream. Because all measurements of flow from the coking operation included cooling water flows, flows for contaminated waste streams were estimated at using results of a recent survey of the steel industry [5]. Further assumptions made in the treatment of coke plant wastewater included the use of benzol effluent for quenching of coke with the excess being treated with other wastes from the coking process and the use of free and fixed leg ammonia stills to reduce ammonia concentrations to levels which would be required for synthesis in biological treatment units leaving only 0.5 - 1.0 mg/l in NH_3-N in the treated effluent.

The treatment processes proposed for the achievement of Level I standards are shown in Figure 7. Following vacuum filtration, it is proposed that sludge resulting from the treatment processes be returned to the coke ovens for incineration in the coking process. This should result in significant savings for sludge handling and disposal and should not be detrimental to the quality of coke produced. Provisions for the addition of phosphorus were made to provide adequate nutrients for the activated sludge process. Treatment required for Level II, shown in Figure 8, was essentially the same as for Level I except for the higher degree of demineralization required.

Because of the high concentration of industry on the lower Cuyahoga, it was estimated that the total dissolved solids level required to meet State of Ohio standards would be 2,000 mg/l. The

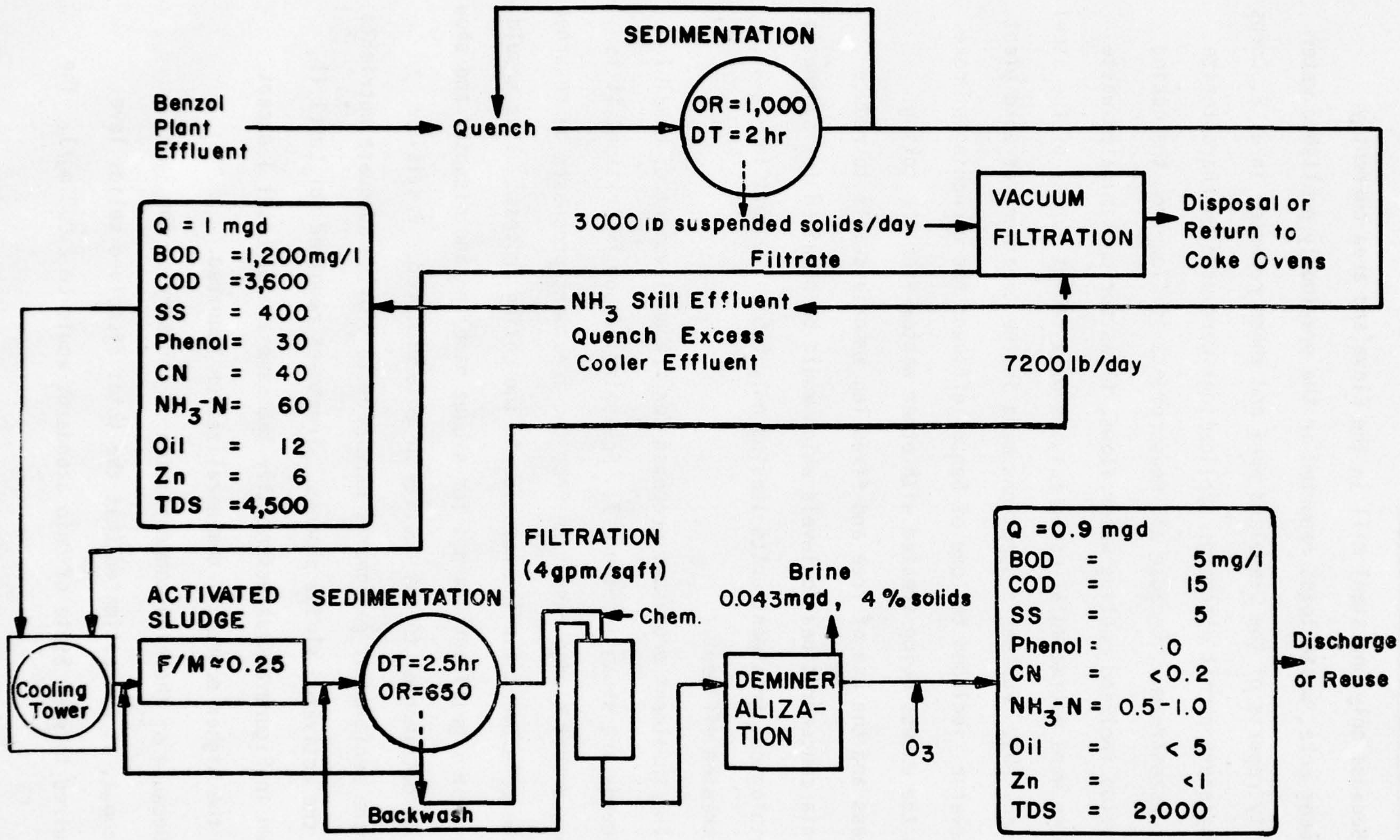

FIG. 7. COKE PLANT TREATMENT SEQUENCE-LEVEL I STANDARDS

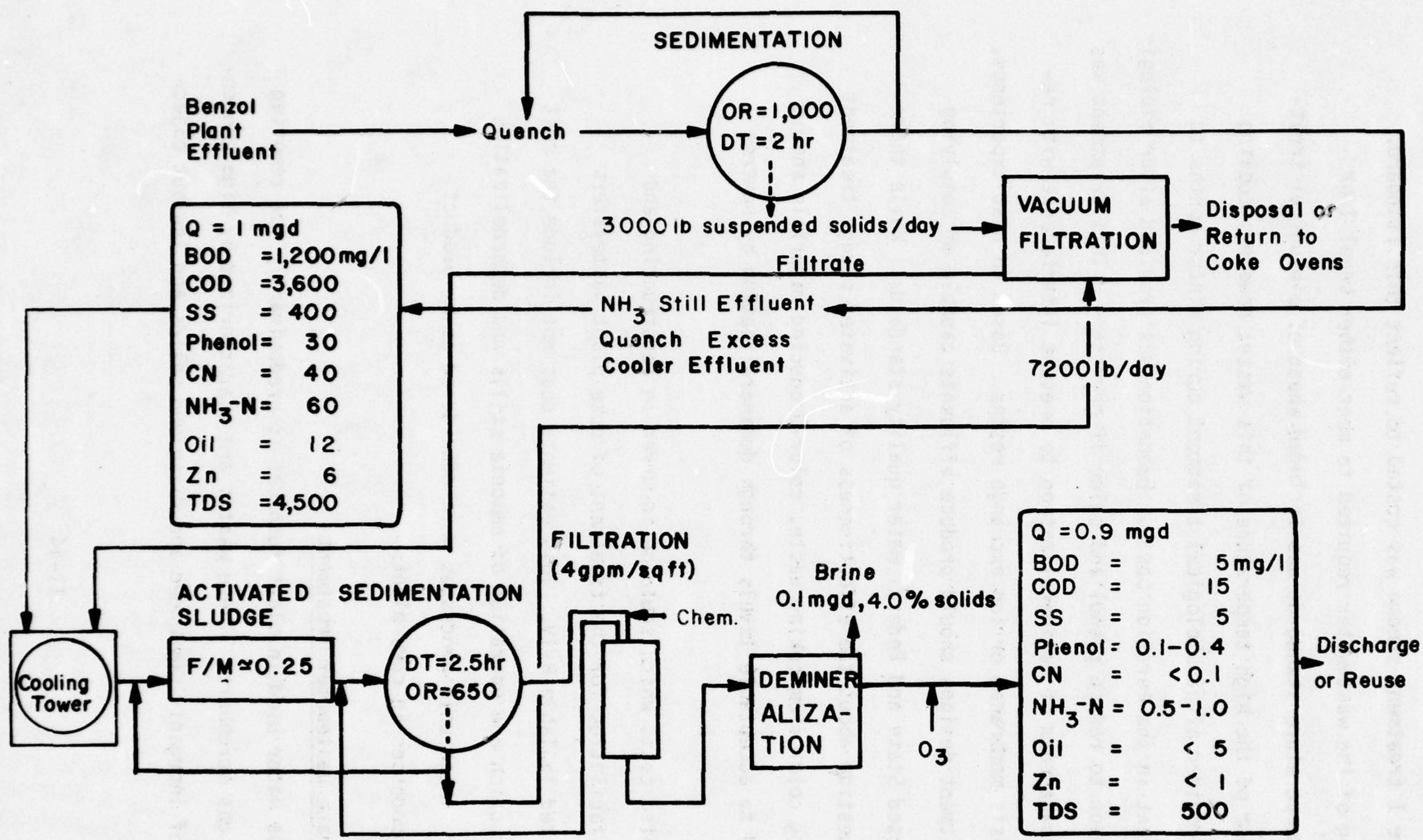

FIG. 8. COKE PLANT TREATMENT SEQUENCE-LEVEL II STANDARDS

Alternative I treatment scheme was costed to reflect this standard.

Cooling of the wastewater required to meet either Level I or Level II temperature standards was included ahead of biological treatment because of the high temperature of this waste; however, cooling might be provided after biological treatment during winter months to conserve heat in the aeration basin. Ozonation was provided after biological treatment to reduce phenol and color if necessary. This treatment was also put downstream of demineralization to prevent interference with reverse osmosis membranes or ion exchange resins. Based on past experience, these treatment designs should produce effluents capable of complying with proposed State and Federal water quality standards. While there is some question about the effectiveness of activated sludge treatment in removing color from coking waste, color-producing materials should be reduced to acceptable levels through demineralization by reverse osmosis.

Estimated costs which sould be incurred in constructing and operating facilities for the treatment of coke plant wastewaters are presented in Table B-IV. This estimate does not include the cost for construction and operation of ammonia stills and dephenolization units since these unit processes were considered as by-product recovery processes in coke plants.

Blast Furnace Wastewater Treatment

Process water used in blast furnaces is predominantly for removing solids in gas scrubbers. These wastes are characterized by high concentrations of inorganic suspended and dissolved solids and low but objec-

tionable concentrations of phenol, cyanide, ammonia-nitrogen, and some heavy metals. Treatment provided for these wastes usually includes sedimentation to recover flue dust which is usually processed in a sinter plant for recovery and reuse as a source of iron ore in blast furnaces. Reuse of water in blast furnaces may be practiced if measures are taken to control the buildup of solids in this system. Excessive concentrations of solids, especially hardness and alkalinity, will result in deposition in piping and clogging of spray nozzles. The reuse of water in blast furnace systems has been reported in several places in the literature [6-9]. This work has generally shown that systems operated with 80% recycle performed essentially like once-through systems. Significantly higher percentages of recycled water have been used in systems where provisions were made for the control of hardness and alkalinity.

Treatment provided for Alternative 1, shown in Figure 9, included sedimentation in a thickener for the removal of the major fraction of ore fines followed by chemical precipitation for additional removal of suspended solids, iron, and any heavy metals which may be present. A separate sedimentation step was included for the removal of ore fines because of the difficulty in handling these high density particles in flocculation and conventional sedimentation systems. For the implementation of Level I standards, it was assumed that water would be reused through blast furnaces with adequate blowdown to prevent the total dissolved solids concentration of the system from exceeding 2,500 mg/l. In this way demineralization of blast furnace wastewaters would not be required to meet State water quality standards. A holding basin and cooling tower which would be required for wastewater recycling were included in the treatment design sequence.

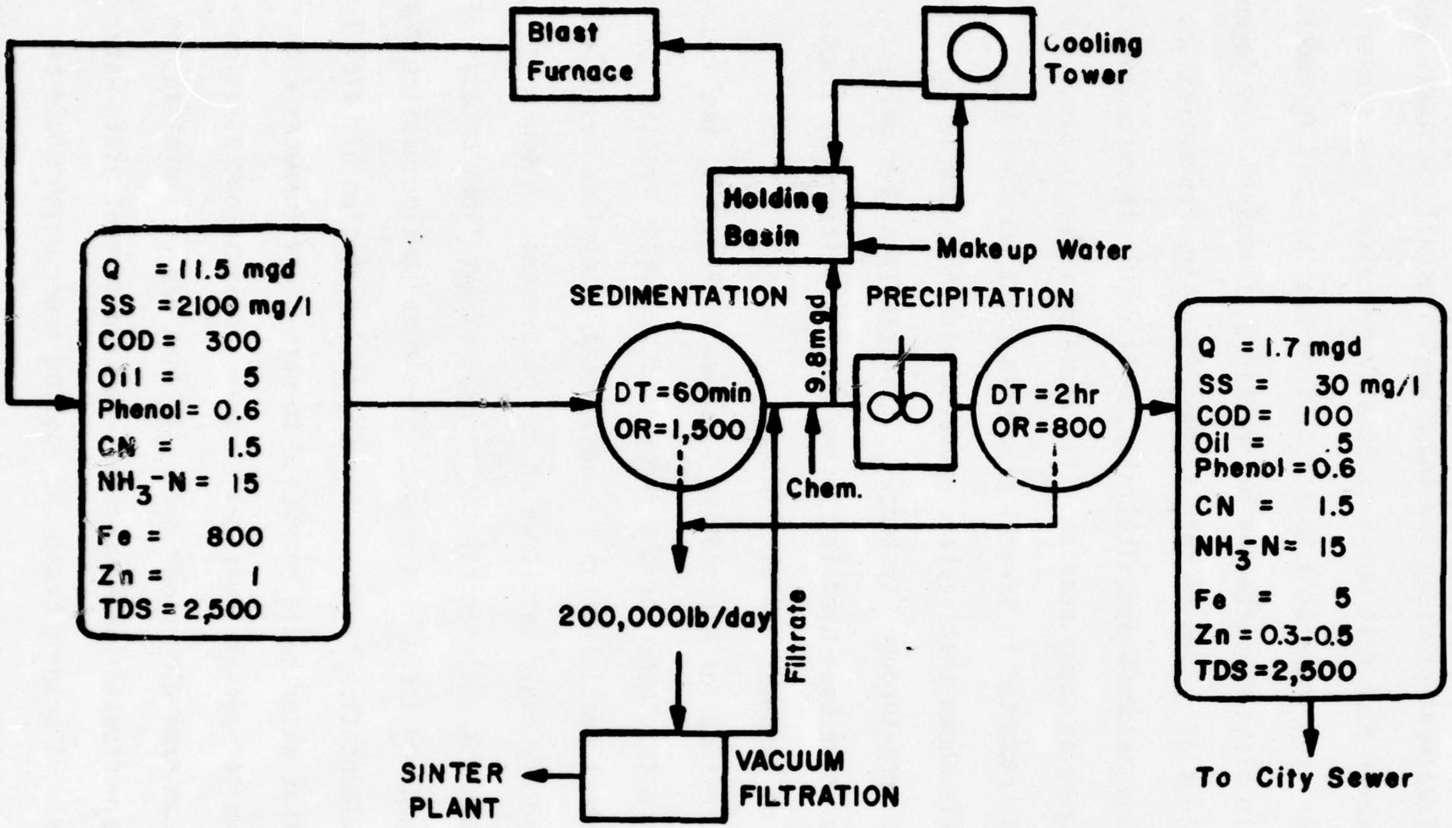

FIG. 9. BLAST FURNACE TREATMENT SEQUENCE - LEVEL I STANDARDS

Treatment processes included in the design for Level II standards, shown in Figure 10, were similar to those provided for treatment to Level I with the exception that demineralization including a filtration pretreatment step were required for compliance with Federal water quality goals.

City of Cleveland officials and steel company personnel have discussed the possibilities for the discharge of blast furnace wastewaters to the muncipal sewer system. While the outcome of these negotiations is uncertain at this time, this practice would seem desirable from the standpoint of removing low concentrations of BOD, phenol, cyanide, and ammonia-nitrogen required to meet the proposed water quality standards. Thus, it was assumed that blowdown from the blast furnace systems would be discharged to city sewers following pretreatment for the removal of heavy metals and dissolved solids as required.

In incorporating plans for maximum in-plant reuse of water into these designs, changes in pollutant loads which will result from this practice should be pointed out. McMichael [7] presented data showing that the buildup of pollutants in water recycled through blast furnace gas washer systems did not increase proportionally with the degree of recycle. Only slight increases in concentrations of phenol, cyanide, and ammonia-nitrogen with increasing recycle ratios indicated that significant amounts of these substances were being discharged to the atmosphere. Thus, as constituents in recycled water streams become more concentrated, gas scrubbing systems may become less efficient in removing these substances from blast furnace off gases. In this case conservation of water might

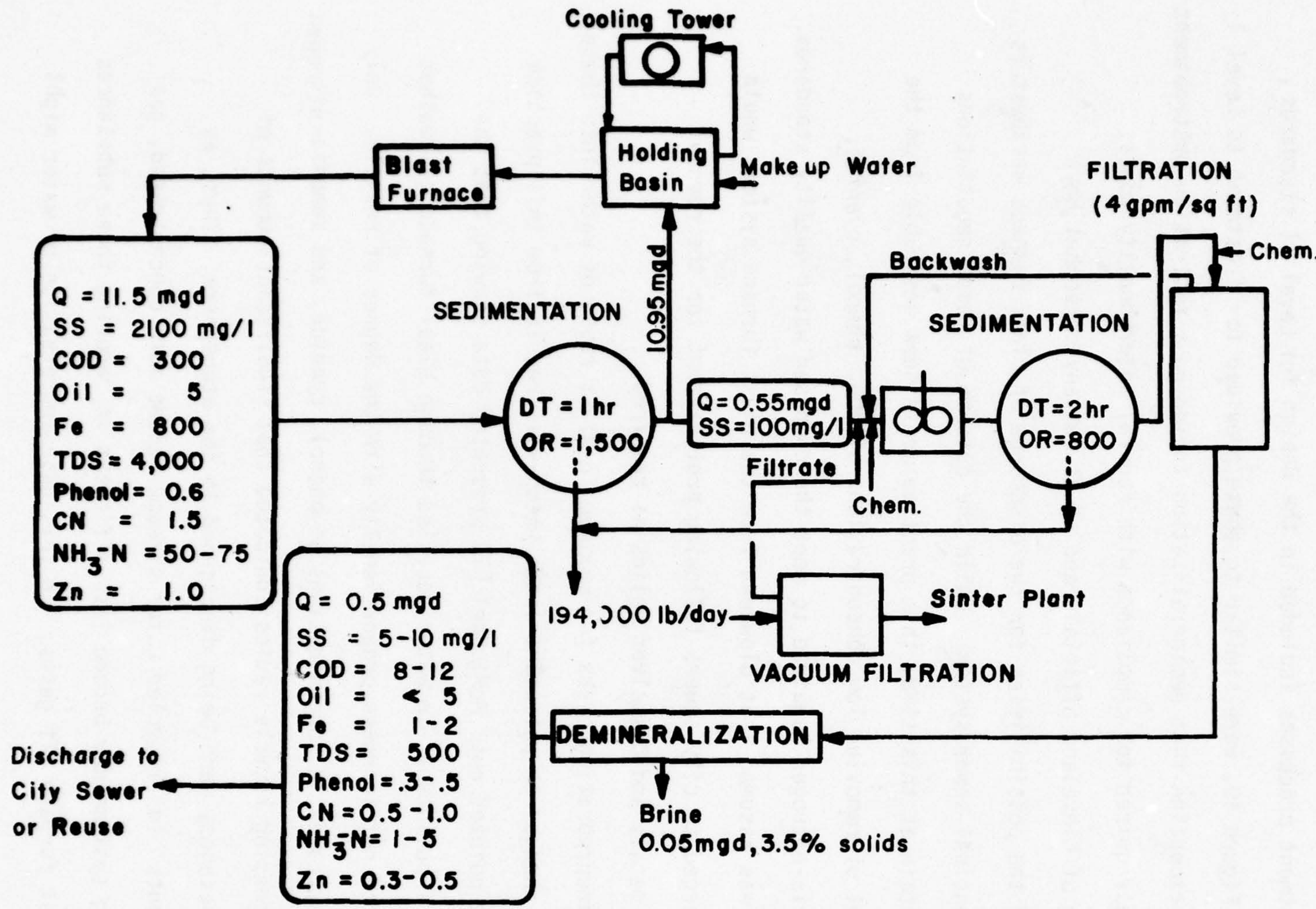

FIG. 10. BLAST FURNACE TREATMENT SEQUENCE - LEVEL II STANDARDS

result in increased emissions of air pollutants.

Estimated cost for the treatment of blast furnace waste waters are summarized in Table B- V.These costs include allowances for holding basins and cooling towers required for reuse of water. However, allowances were not made for additional piping and process modifications which might be required to allow recycle of waste water. Estimates do not include thickeners used for the recovery of flue dust nor the portion of vacuum filtration costs associated with dewatering of ore fines since this would result in the recovery of a valuable by-product.

Steel Furnace and Wastewater Treatment

Waste originating from the production of steel in open hearth, electric hearth, and basic oxygen furnaces are similar to those produced in blast furnace operations with the exception that cyanide, phenol, and ammonia-nitrogen are not present in significant concentrations. Conversely, concentrations of heavy metals are frequently in steel furnace wastes due to the addition of various alloying metals with the charge to the furnace. The waste treatment sequence for Level I standards shown in Figure 11 includes sedimentation and filtration for the removal of suspended solids followed by cooling to meet State effluent temperature requirements. In addition provision was made for the addition of a chemical coagulant to aid in removing very fine iron particles and heavy metals from the waste. The design for Level II standards shown in Figure 12 includes the same treatment processes with the exception that provisions were added for maximum

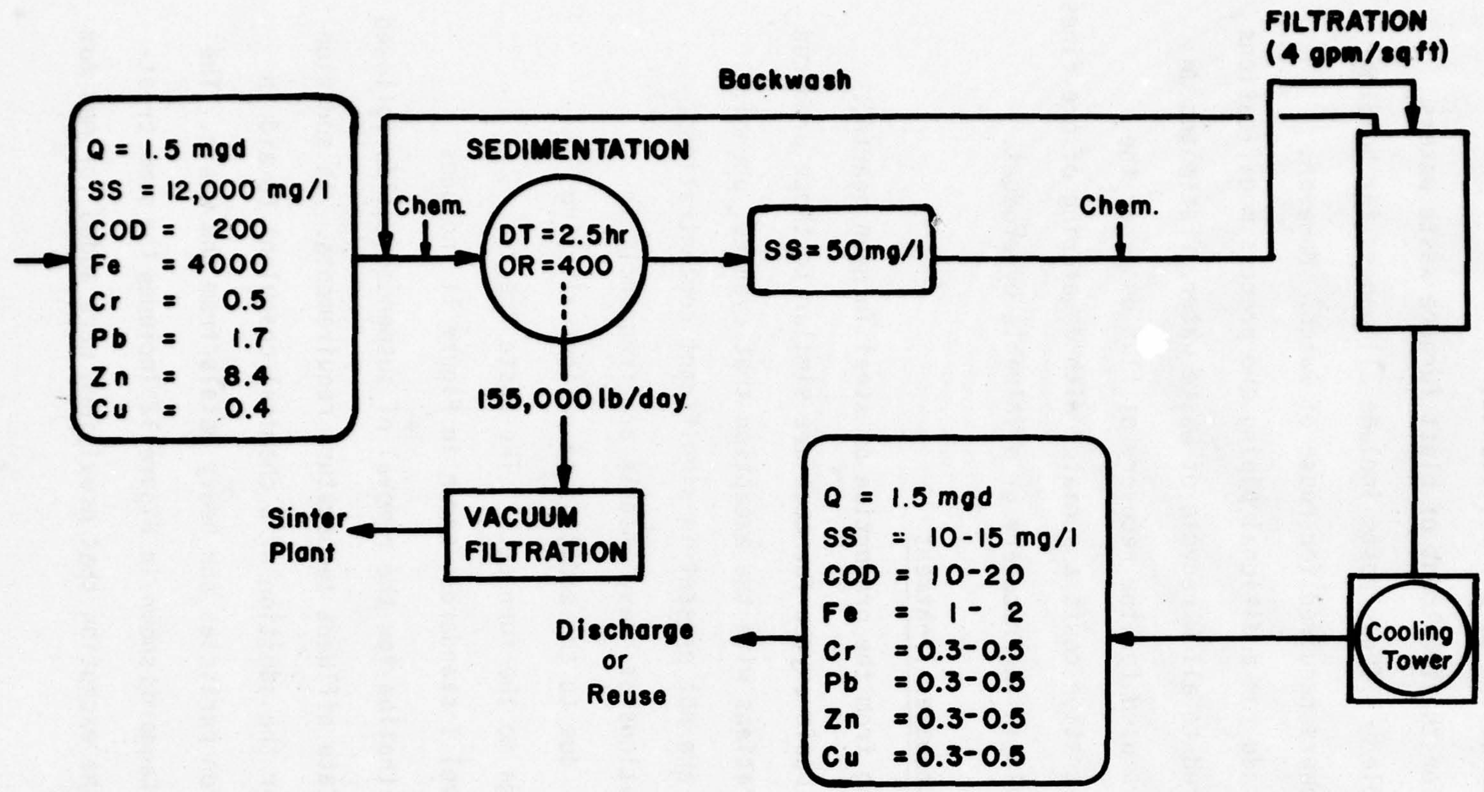

FIG. 11. STEEL FURNACE TREATMENT SEQUENCE - LEVEL I STANDARDS

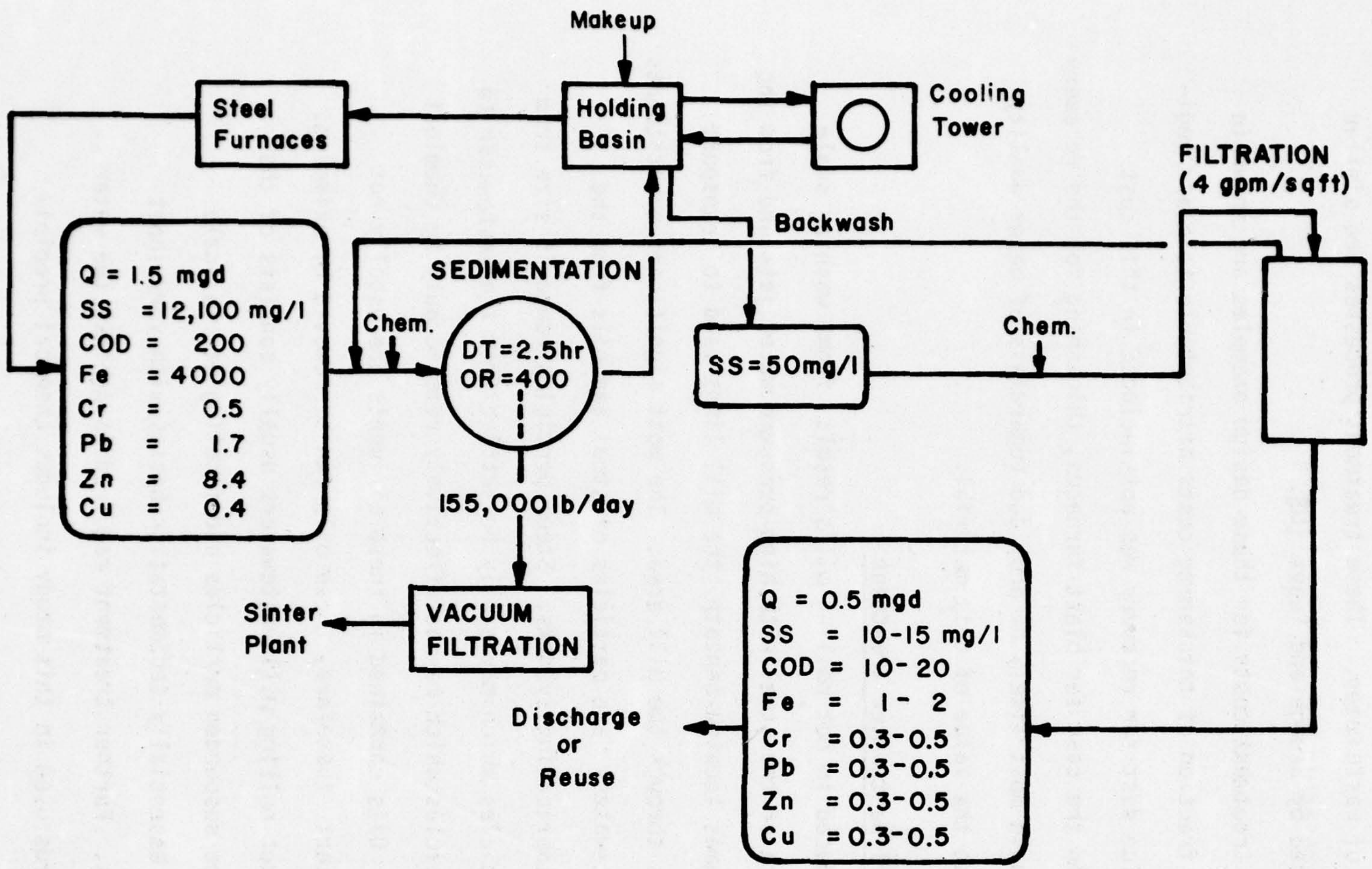

FIG.12. STEEL FURNACE TREATMENT SEQUENCE -LEVEL II STANDARDS

in-plant reuse of wastewater. These treatment processes are similar to ones described by Brough and Voges [10].

Estimated treatment costs for these design examples are shown in Table B-VI. The fraction of thickening costs attributable to plain sedimentation of flue dust for recovery was not included in this cost estimate. As in the case for blast furnaces, thickening for the recovery of flue dust would most likely be provided regardless of water quality standards due to the value of this material.

Hot Rolling Mill Wastewater Treatment

Waste produced in hot rolling mills result from washing scale from the surface of the steel with high pressure water jets and from the flushing of flumes located beneath the mill lines used to transport scale particles through the mill area. The most significant constituents present in wastewaters are particles of steel and oils from the hydraulic and lubricating systems. Steel particles range in size from very large particles which may easily be settled from the wastewater to sub-micron particles which may be effectively removed only by chemical precipitation. Oils contained in these effluents are usually not miscible in water; therefore, these oils can be removed by skimming. Treatment for hot rolling mill wastewaters usually consists of the removal of large suspended particles and floating oil in scale pits which are essentially sedimentation basins with very short detention times. Further treatment required to achieve the water quality standards used in this study includes chemical precipitation and sedimentation for Level I standards and this

treatment plus filtration for the attainment of effluent concentrations specified for Level II standards. In addition it is anticipated that additional cooling of the effluent to be discharged for Level II standards would be necessary to meet the maximum 1° C temperature increase. Process flow diagrams for the treatment of waste from hot rolling mills are shown in Figures 13 and 14 for Level I and Level II, respectively. These treatment sequences are similar to those which have been recently constructed at one of the steel mills in Cleveland as described by Berkbile [11]. Little information was located concerning the accumulation of dissolved solids in waste from hot mills. Data filed by the steel mills in Cleveland for U. S. Army Corps of Engineers discharge permits indicated that dissolved solids concentrations will not be objectionable for Level I or Level II water quality criteria. However, because large quantites of cooling water were included in discharges sampled for the permit applications, the exact quantities of dissolved solids contributed by process waste from hot rolling mills were difficult to identify. If larger concentrations of dissolved solids are contributed by hot rolling processes, demineralization of waste water effluents might be required for the achievement of Level II standards.

Costs estimated for the treatment of hot rolling mill waste waters shown in Table B-VII do not include costs which would be incurred for the removal of scale and oil in scale pits. Included in the estimate are all major unit treatment processes required for the attainment of the specified water quality objectives. Additional costs for piping and

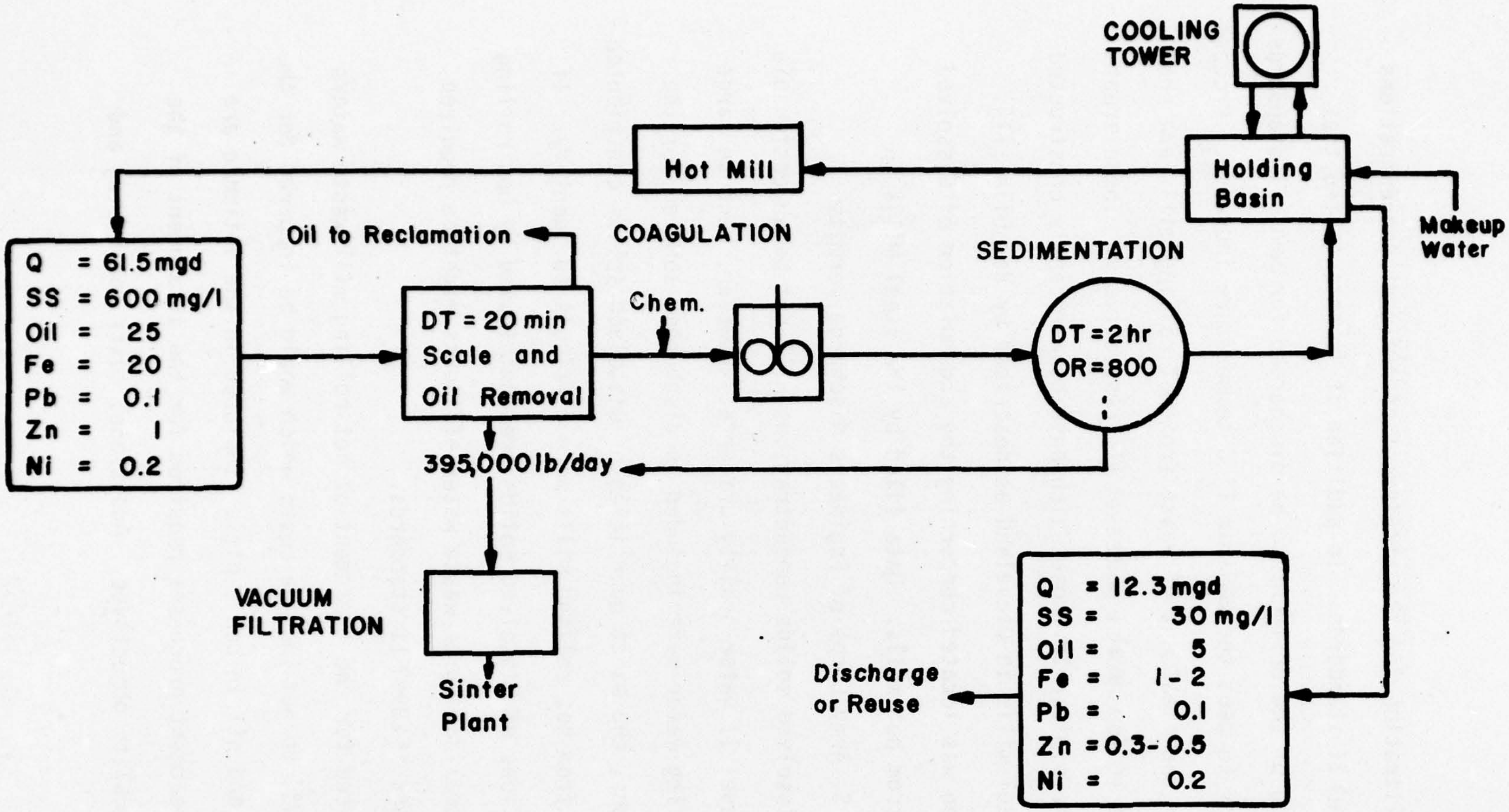

FIG. 13. HOT MILL TREATMENT SEQUENCE - LEVEL I STANDARDS

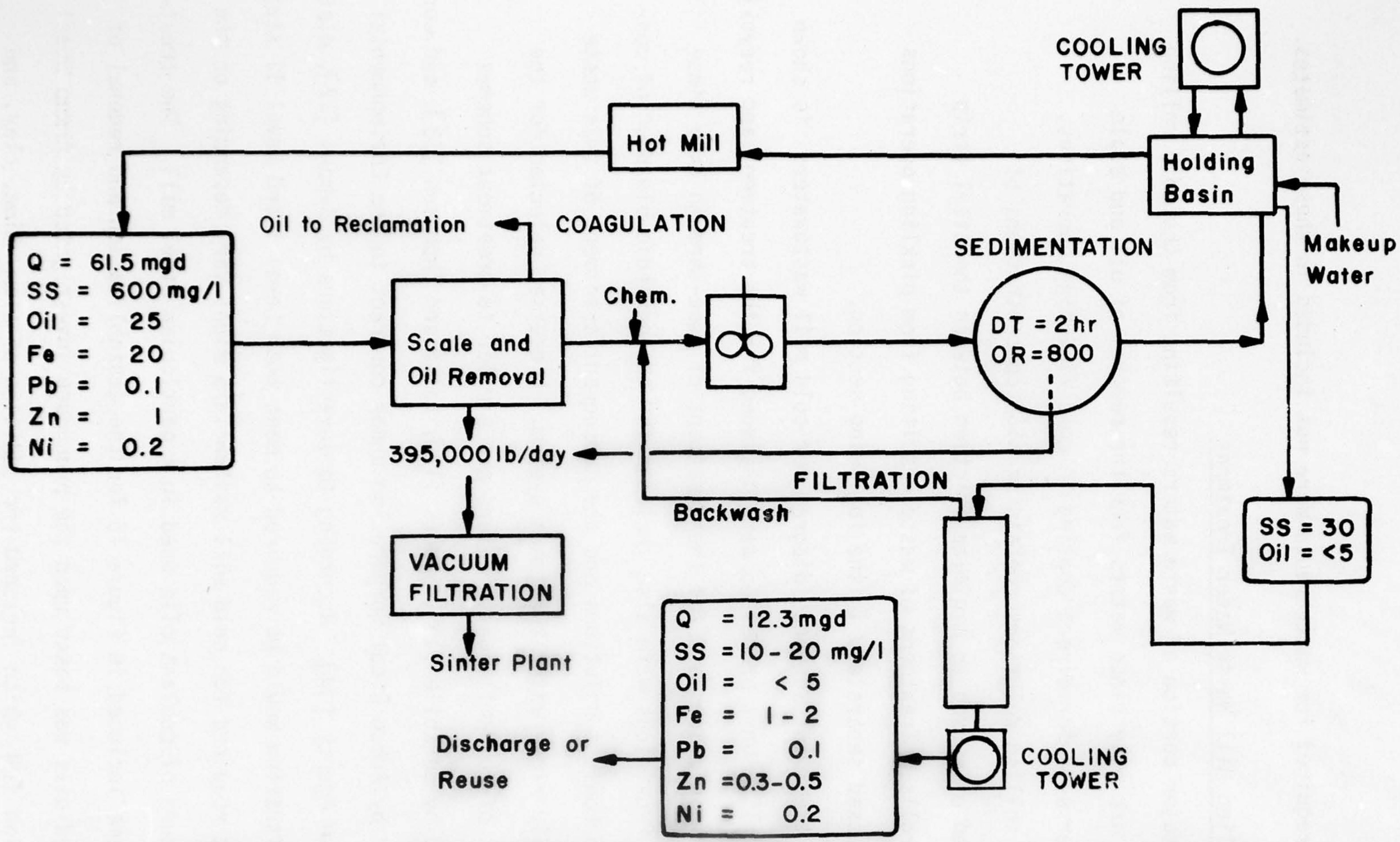

FIG. 14. HOT MILL TREATMENT SEQUENCE -LEVEL II STANDARDS

pumping required for water reuse were not included in these estimates.

Cold Rolling Mill Waste Water Treatment

The major portion of waste waters resulting from the cold rolling of steel are oily rinse waters from the removal of oil and scale, from water used for direct cooling in cold finishing operations, and from rolling solutions containing high concentrations of emulsified oils used to minimize friction between the steel strip and the rolls. Treatment of waste resulting from pickling operations are discussed separately in the following section.

The treatment sequence diagram for cold mill wastewaters is shown in Figure 15. Unit processes were included for the treatment and recycling of coolent solutions and for the treatment of once-through oily rinse waters. Provisions were also included for the periodic blowdown of contaminated coolant solutions and the subsequent treatment of this waste in the oily rinse water treatment system. Processes selected for the treatment of cold mill waste waters are similar to treatment schemes described by Berkbile [11], Symons [12], Foltz and Thompson [13], and work performed by Armco Steel Corporation under contract to the Environmental Protection Agency [14]. According to investigations by Symons [12], diatomaceous earth filtration would be required to meet both Level I and Level II standards. Treatment required for cold mill wastewaters might vary depending on the exact nature of coolant oils used in a particular steel mill. The treatment scheme included in Figure 15 for the destablization and removal of emulsified oils was based upon the procedure investigated by Armco Steel Corporation [14] which included the addition of alum, lime, clay, and

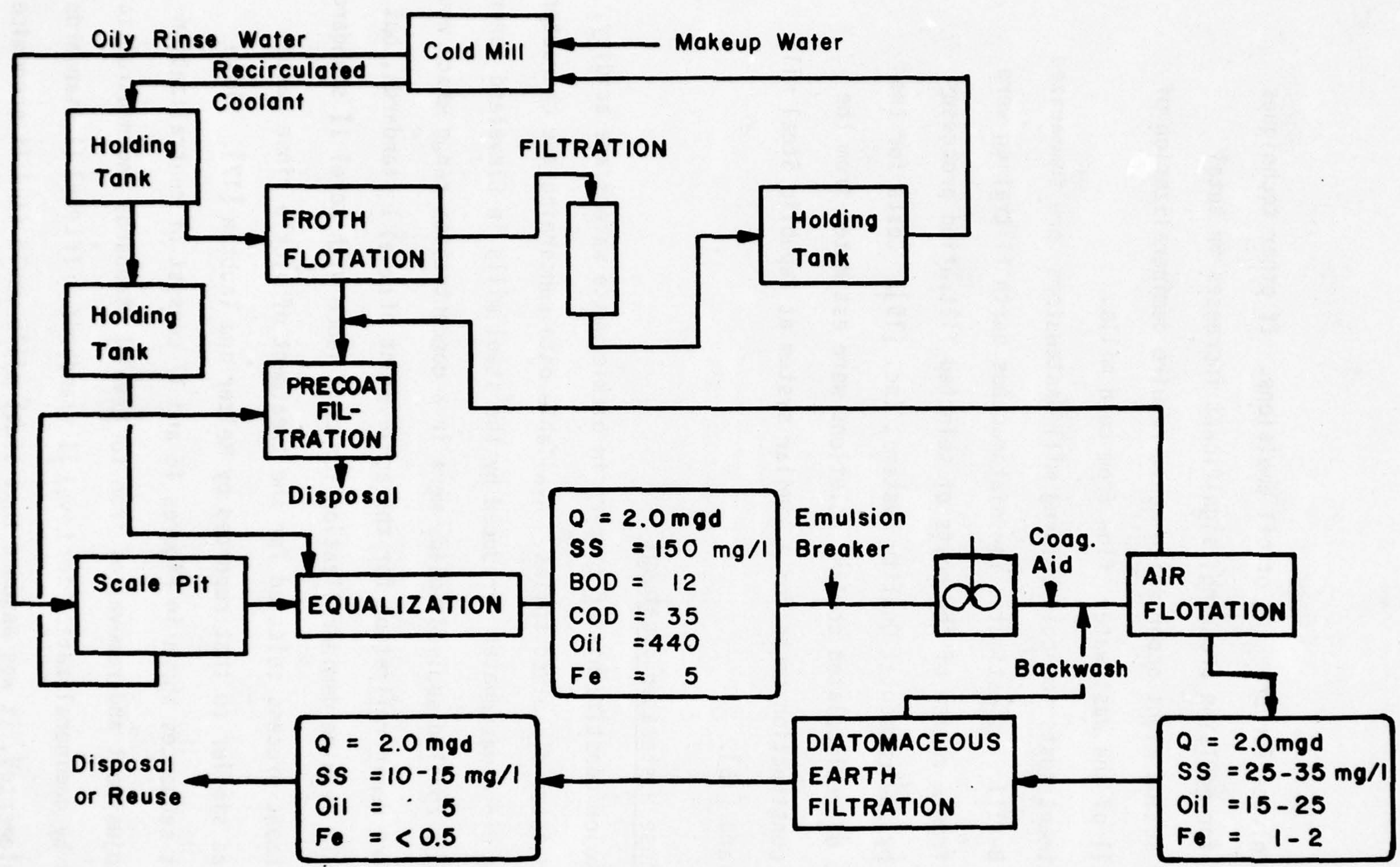

FIG. 15. COLD MILL TREATMENT SEQUENCE - LEVEL I AND II STANDARDS

polyelectrolytes for breaking of oil emulsions. If other techniques were used for emulsion breaking, significant increases in total dissolved solids might occur which would require demineralization of part or all of the wastewater flow from cold mills.

Treatment costs for cold rolling mill wastewaters are summarized in Table B-VIII. Cost estimates for diatomaceous earth filtration were obtained from a review of the costs of selected filtration processes compiled by Environmental Quality Systems, Inc. [15]. Costs for the treatment of recirculated coolant solutions were estimated from the reported construction costs for a similar system at Republic Steel mill in Cleveland [16].

Pickle Rinse Wastewater Treatment

The major constituents of concern in pickle waste waters are acidity, iron, and total dissolved solids. Available data concerning the characteristics of pickle rinse wastewater produced by the steel mills in Cleveland generally showed that total dissolved solids were in a concentration range which would not require demineralization for the achievement of Level I standards, but which would require demineralization for compliance with Level II standards. The treatment process selected for the treatment of pickle rinse wastewaters was similar to that reported by Melzer and Taubken [17]. These treatment sequences shown in Figures 16 and 17 consist of neutralization for pH adjustment and removal of iron for Level I standards and neutralization followed by demineralization for Level II standards. If Level II standards were implemented, it was assumed that steel mills would find it economically feasible to reduce rinse flows by approximately 50 percent through process

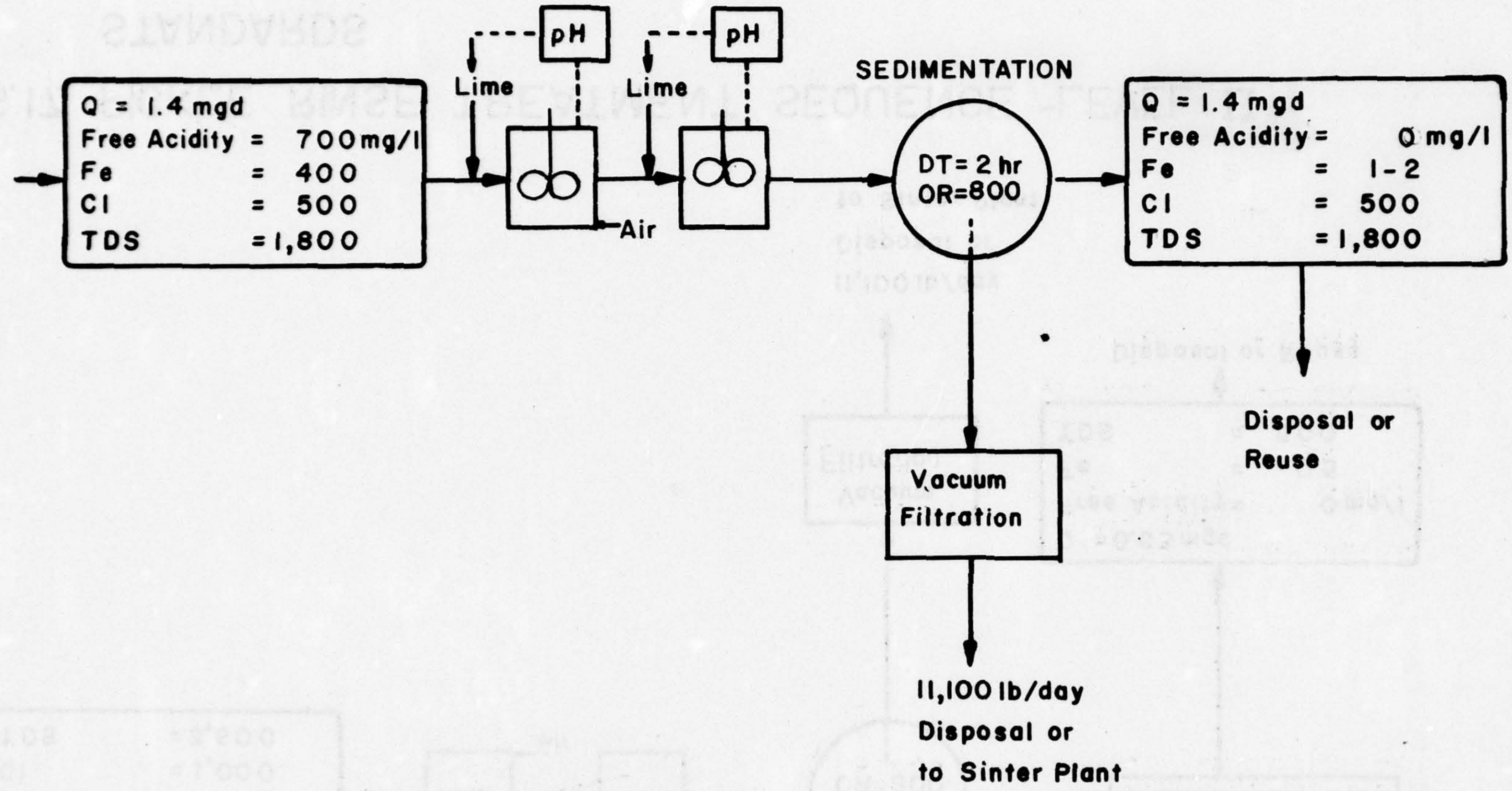

FIG.16. PICKLE RINSE TREATMENT SEQUENCE -LEVEL I STANDARDS

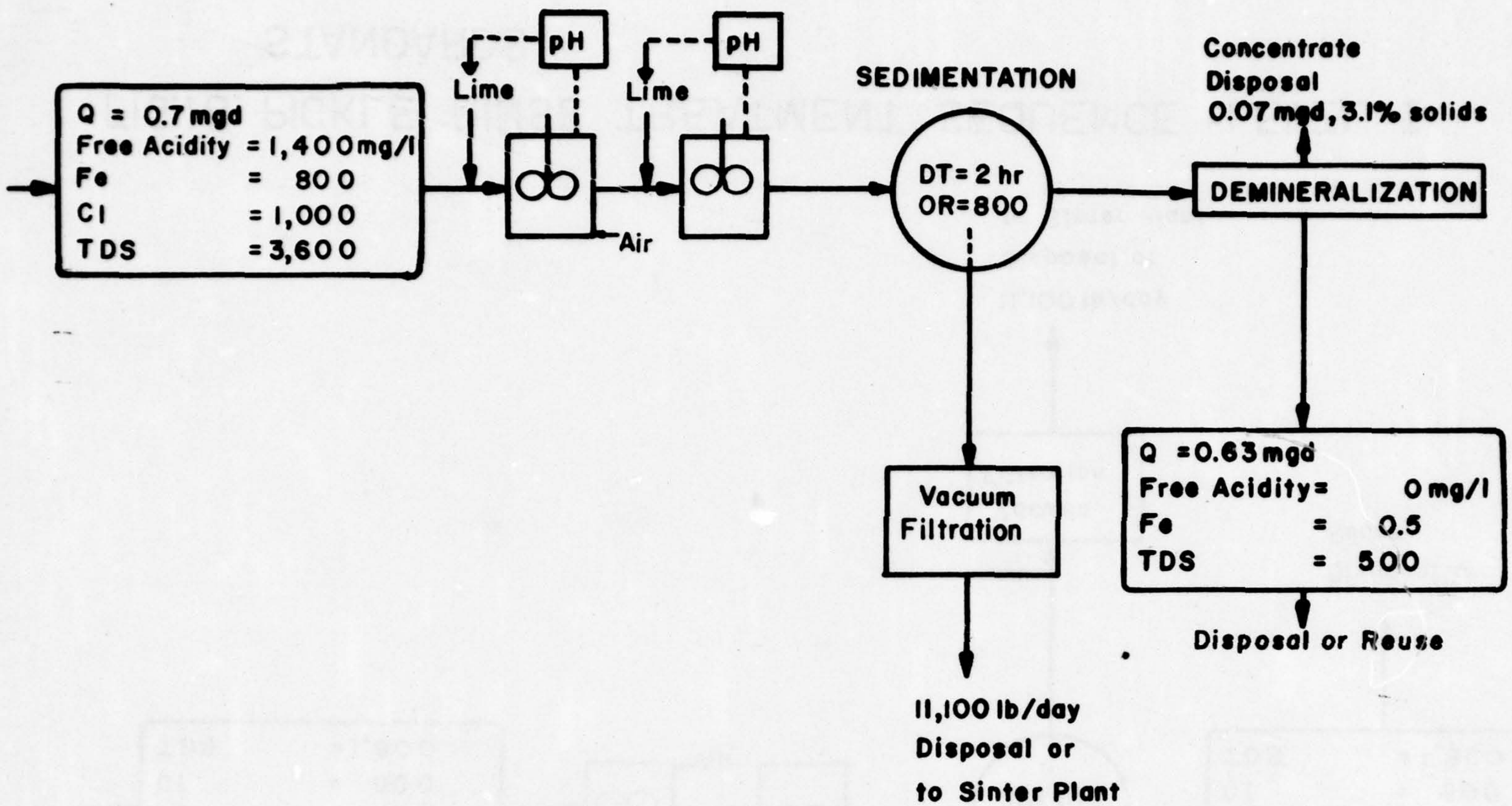

FIG. 17. PICKLE RINSE TREATMENT SEQUENCE -LEVEL II STANDARDS

modifications. It was assumed that while waste flows would be reduced by approximately 50 percent, constituent loadings would remain approximately the same resulting in a two-fold increase in concentration.

Cost estimates of the treatment of pickle rinse wastewaters are summarized in Table B-IX. Costs for the design example treatment plant for Level I standards were based on a flow of 1.4 mgd, while treatment costs for Level II standards reflected the estimated 50 percent decrease in flow and were based on a flow of 0.7 mgd. However, this estimate does not include the cost required for process modifications necessary to achieve this reduction in flow.

TREATMENT OF WASTE REQUIRING REMOVAL OF OIL, METALS, AND TOTAL DISSOLVED SOLIDS

Waste from several industrial categories including petroleum products, SIC 29; primarily metal industries SIC 33, excluding blast furnaces and steel production; fabricated metal products, SIC 34; non-electrical machinery, SIC 35; electrical machinery, SIC 36; and transportation equipment, SIC 37 require the removal of oil, various heavy metals, and, in some cases, total dissolved solids. Because treatment required for waste from these industries do not always correspond with the listing of industries by the Standard Industrial Classification, designs for these wastewater treatment facilities are discussed with respect to capabilities of each design sequence rather than the treatment processes required for a particular industrial category. In order to treat these wastes, individual treatment sequence diagrams were developed to remove the following constituents:

1. Oil and total dissolved solids.
2. Heavy metals and cyanides resulting from plating operations.

3. Removal of heavy metals and total dissolved solids.
4. Removal of heavy metals from wastewaters not requiring demineralization.

Each individual treatment scheme will be disscussed separately below.

Treatment of Wastewater Requiring Oil Removal

Four SIC categories requiring the removing of oil and total dissolved solids were identified from wastewater characterization data contained in the Phase I report. Included in this category are waste produced in segments of SIC categories 29, 33, 34, and 35. Treatment requirements for these wastes were further identified as waste containing moderate total dissolved solids concentrations which would require demineralization for the achievement of Level II standards, but not for Level I standards and wastes containing higher total dissolved solids concentrations which would require demineralization for both Level I and Level II standards. Treatment sequence diagrams for these wastes are shown in Figures 18-20. The treatment proposed for wastewaters not requiring demineralization for Level I standards included oil separation in an API-type separator. While the effluent from this treatment sequence would not meet oil concentrations required for Level I standards, the remaining oil concentration of approximately 40 mg/l could be removed by adsorption onto biological flocs in biological treatment units. Pretreatment for all other waste streams consisted of dissolved air flotation followed by filtration upstream from demineralization processes. From the data in the Phase I report respective concentrations of soluble and insoluble oils were separately identified. Therefore,

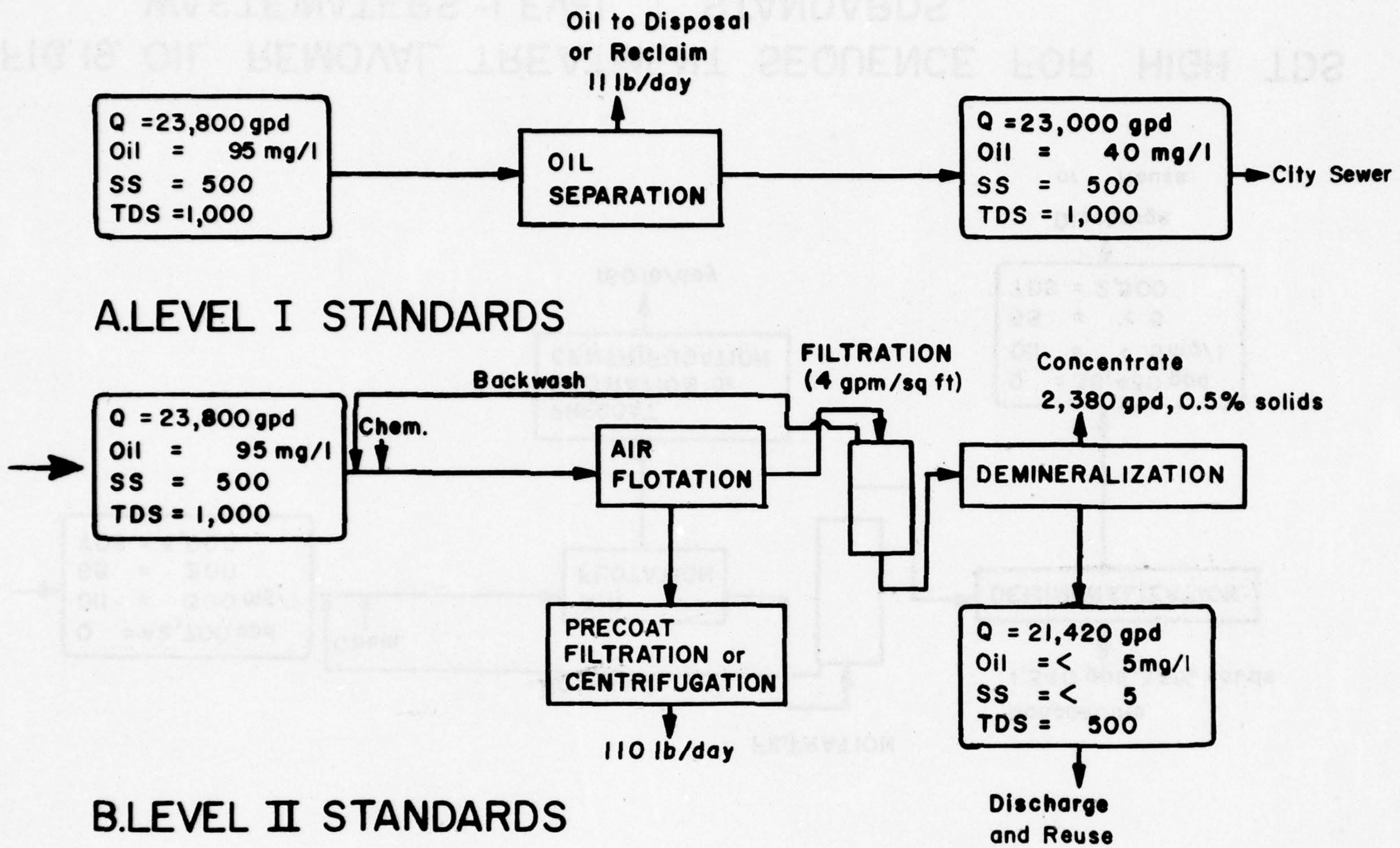

FIG.18. OIL REMOVAL TREATMENT SEQUENCE FOR MODERATE TDS WASTEWATERS

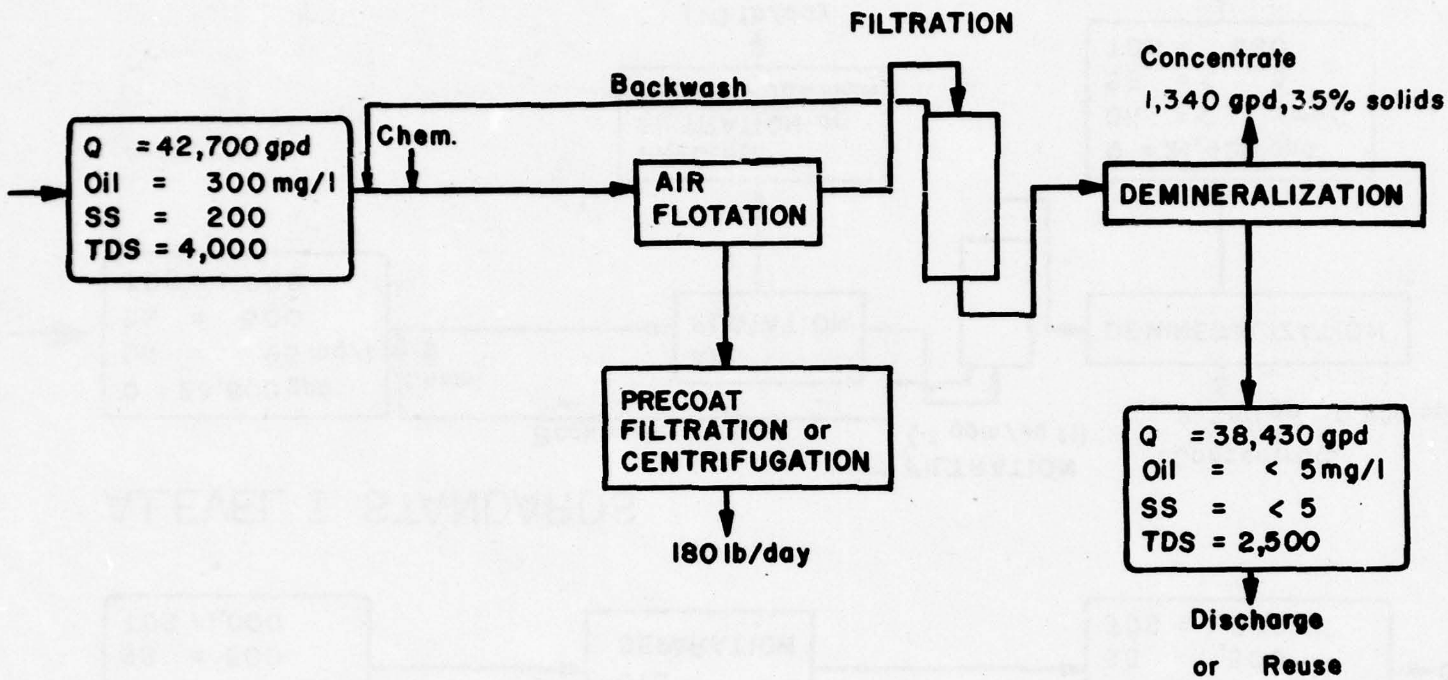

FIG. 19. OIL REMOVAL TREATMENT SEQUENCE FOR HIGH TDS WASTEWATERS - LEVEL I STANDARDS

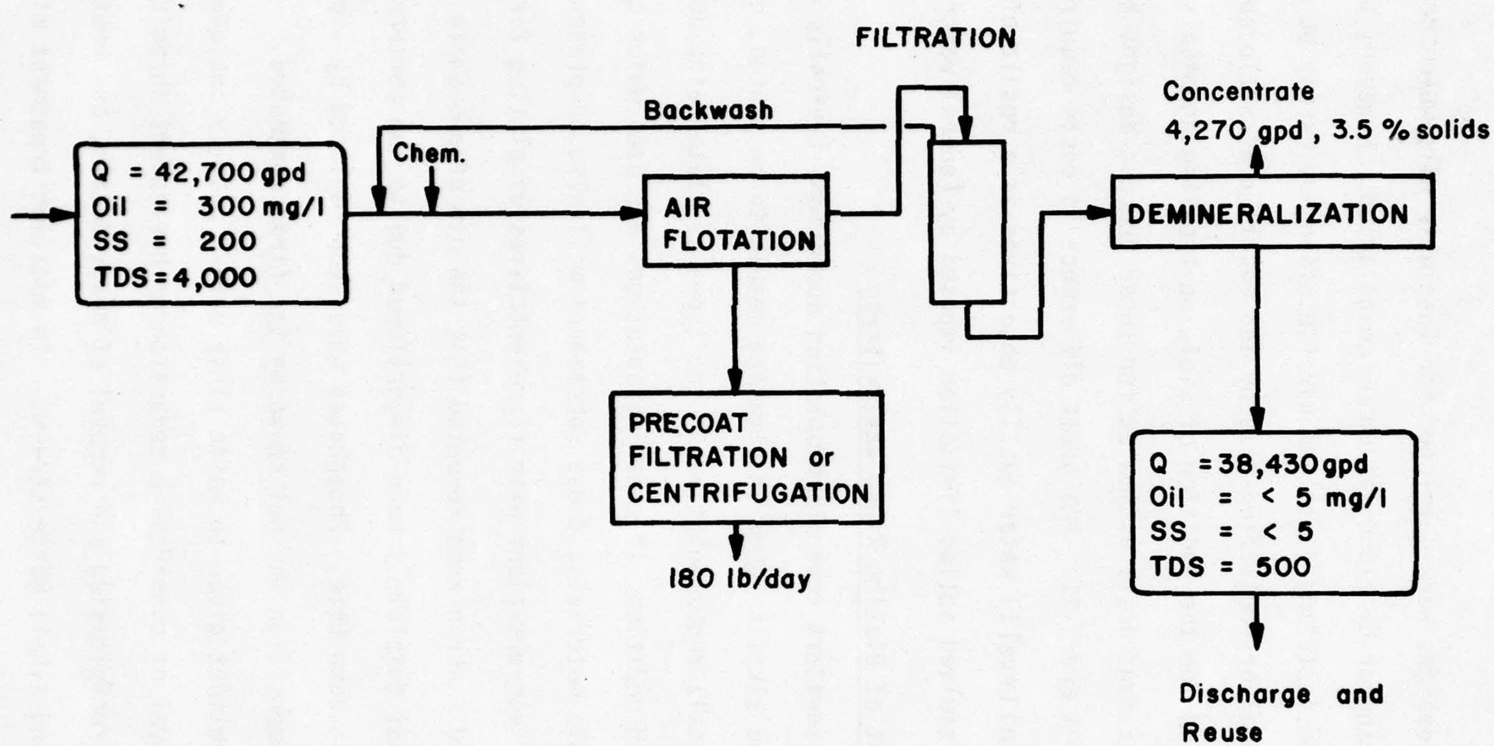

FIG. 20. OIL REMOVAL TREATMENT SEQUENCE FOR HIGH TDS WASTEWATERS - LEVEL II STANDARDS

process designs were developed for insoluble oils which could be removed by skimming or by flocculation and coagulation. However, treatment sequences including dissolved air flotation may easily be modified for the removal of emulsified oils by the addition of a flocculation tank and facilities for the addition of emulsion-breaking chemicals.

Treatment costs estimates for these process designs are shown in Tables B-X and B-XI. The great difference in costs required to achieve Level I and Level II water quality objectives is a result of a more stringent total dissolved solids limitation imposed by federal water quality goals.

Treatment of Plating Rinse Wastewaters

Wastewaters from electroplating operations typically contain acids and alkalis used in cleaning metals to be plated, cyanides, and heavy metals representative of the types of plate being done by a particular firm. In addition, if cleaning solutions are used which contain phosphates or organic materials, these substances will also be present in wastestreams. However, conversations with representatives of plating firms in the Cleveland - Akron area revealed that the use of phosphate cleaning solutions has almost completely been discontinued due to the concern for phosphate levels in Lake Erie. Phosphates have been replaced by proprietary solutions whose composition was not known by the firms contacted.

Treatment given to waste rinse waters usually includes provisions for the removal of cyanides, a reduction of hexavalent chromium to the trivalent state, precipitation and removal of heavy metals, and neutralization of acidic and alkali waste streams. In addition treatment might be required for the removal of phosphates or organic matter if these types of cleaning

solutions are used. Because of the toxic nature of these wastes and because of the concentration of valuable heavy metals contained in wastestreams, many methods have been proposed for the treatment of once-through rinse waters including the recovery of heavy metals for reuse in plating baths. Reviews of processes applicable to the treatment of metal finishing wastes have recently been prepared by Battelle Memorial Institute [19,20]. Of the several methods which have been proposed for the treatment of plating rinse waters, destruction of cyanides using the alkaline chlorination process and precipitation of heavy metals or the removal of cyanides and heavy metals by ion exchange have been most commonly used. The application of ion exchange for the treatment of metal plating wastes has been reported by Von Ammon [21], Hesler [22], and Tyler [23]. The use of ion exchange appears to be most attractive for large electroplating shops which use only a few metals for plating operations. In these cases the recovery of metals in ion exchange regenerant solutions for reuse in plating baths might be economically feasible. However, for smaller plating shops using a wide variety of metals in plating processes, a separate treatment system must be installed on each rinse line. It is highly doubtful that recovery would be economically feasible in these situations.

While ion exchange may be used for the treatment of mixed rinses, chemical methods for cyanide destruction and precipitation of heavy metals appears to be the least costly treatment methods where by-products are not recovered. This type of treatment for plating wastewaters have been

described by O'Connor [24], Snowden [25], and Curry [26]. Because the electroplating industry in Cleveland - Akron area is predominantly composed of small shops which, according to the inventory included in the Phase I report, use a variety of metals, these treatment methods were used as the basis of design for the treatment sequences shown in the Figures 21 and 22. These treatment sequences apply to SIC 3471, electroplating and coating industries, as well as other industries in SIC categories 34 and 35.

In treating to Level II water quality objectives, it was assumed that industries would find it economically feasible to reduce rinse flows through process modifications in order to minimize waste water treatment costs. It was assumed that water requirements for rinsing would be reduced by 50% and, further, that 50% of the treated wastewater would be returned for in-plant reuse. While greater reductions in net water usage might be achieved in some plating shops, cost of implementing process changes is considerably greater for older established industries than for new plants. In addition some industries in the Study Area have already taken measures to reduce rinse flows, so that the assumption of reduced water usage used in this study is believed to be representative of overall reductions in water use which could be achieved.

Alternative treatment methods which might be used to achieve Level II water quality standards include ion exchange treatment of rinse waters. In these cases ion exchange would be used in place of precipitation followed by reverse osmosis. Individual cases would

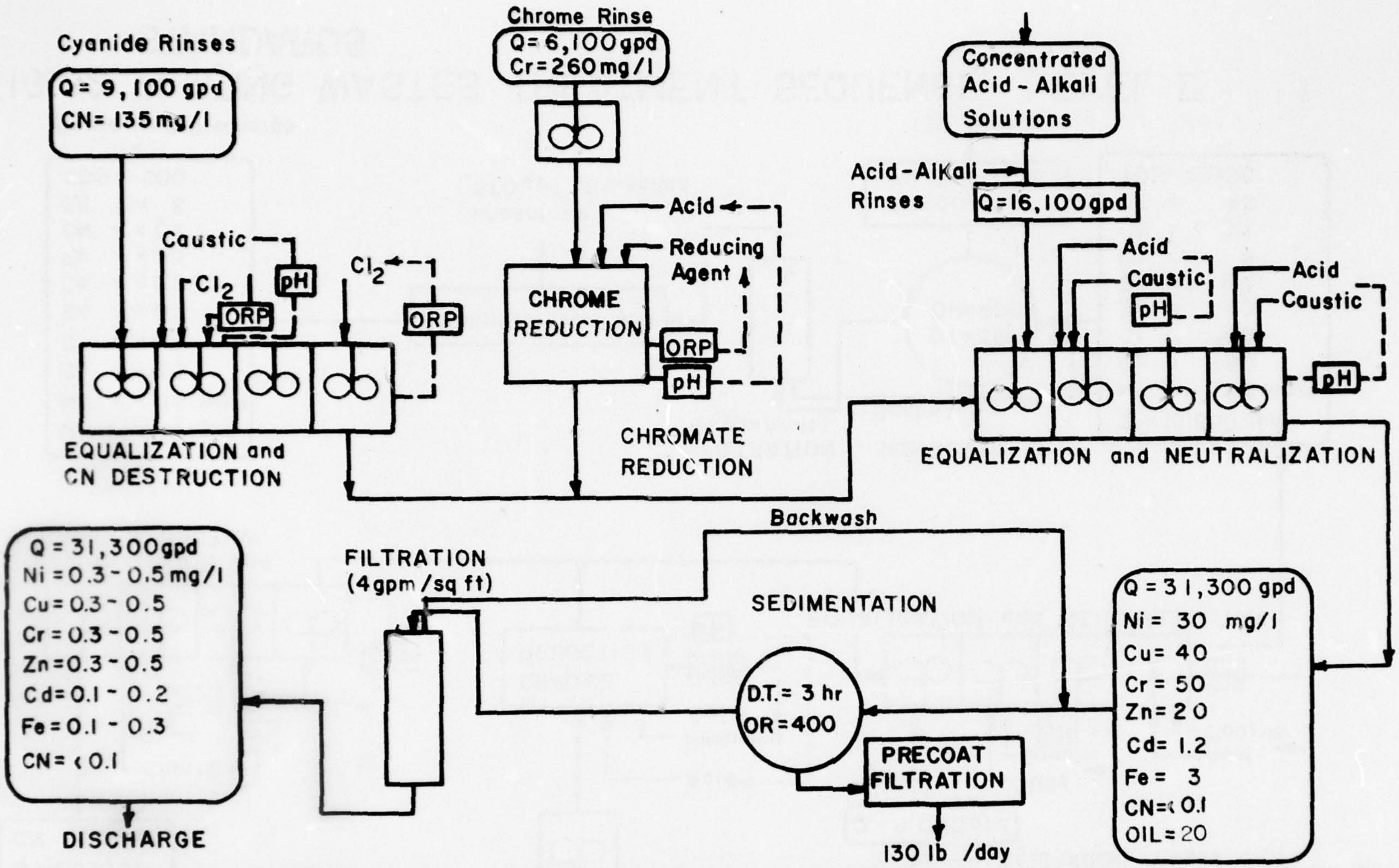

FIG. 21. PLATING WASTES TREATMENT SEQUENCE-LEVEL I STANDARDS

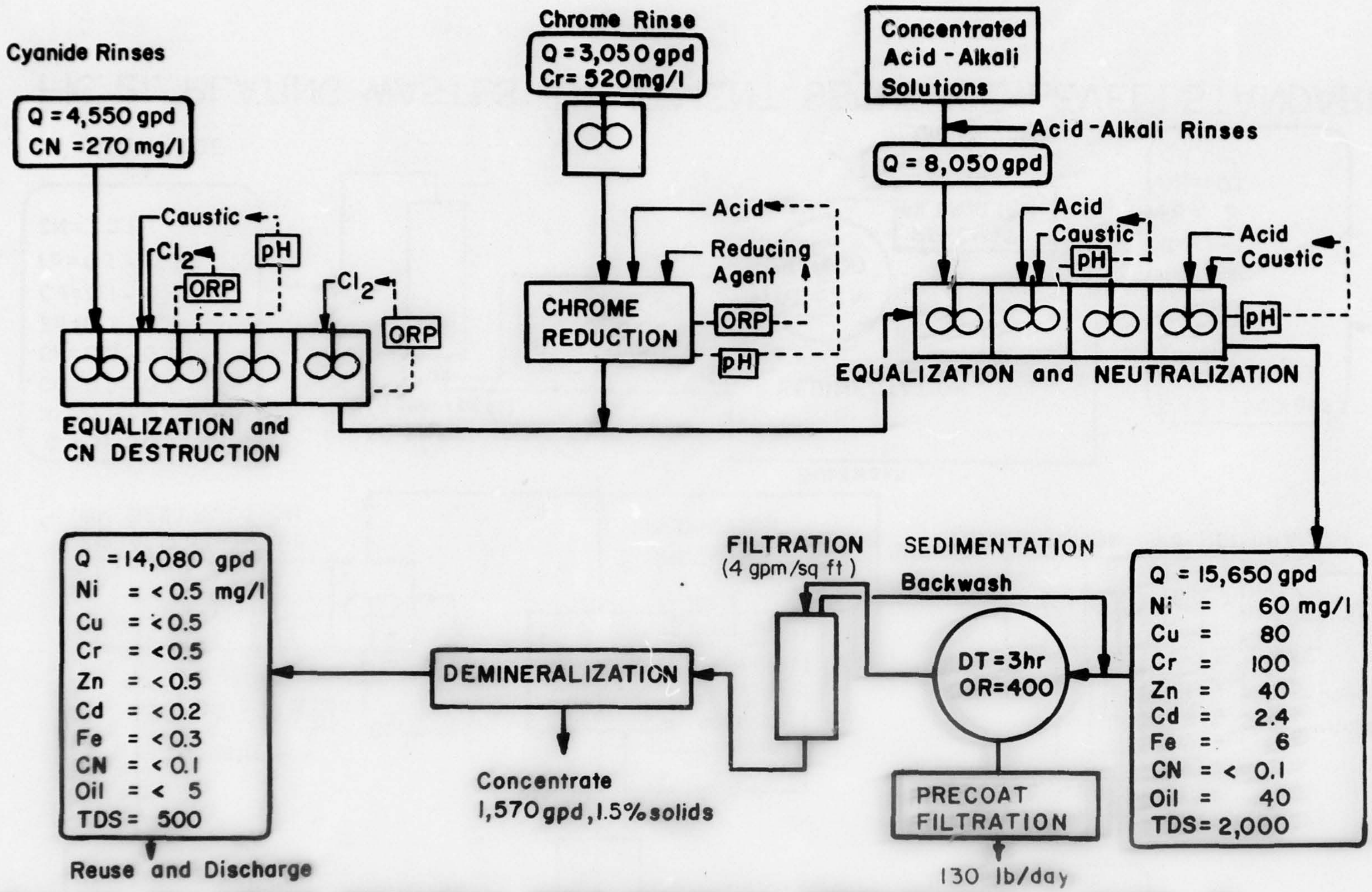

FIG. 22. PLATING WASTES TREATMENT SEQUENCE - LEVEL II STANDARDS

have to be investigated to determine the feasibility of this treatment method. However, filtration might still be required for waste to be treated by ion exchange. In addition, flocculation and coagulation might be required if substantial quantities of oil and grease were present in the wastewater. For the treatment sequence illustrated in Figure 22, it was assumed that destruction of cyanide and precipitation of heavy metals would be required in addition to reverse osmosis treatment for reduction of total dissolved solids. Because no data could be located to demonstrate the selectivity of the reverse osmosis process for heavy metals, it could not be assumed that this treatment to reduce total dissolved solids to 500 mg/l would result in reductions of cyanides and heavy metals to acceptable levels.

Another treatment method which might be advantageous for the achievement of either Level I or Level II standards is the integrated treatment of individual rinse waters described by McDonough and Steward [27]. These treatment methods would require more space than conventional precipitation methods and, therefore, might not be applicable for smaller electroplating shops in which a number of metals are used. For some plants, separate neutralization facilities might be required if the fluctuations in pH are extreme due to rinse flows from cleaning and degreasing operations. In this case acid and alkali rinse waters would be neutralized separately, then combined with effluents from cyanide destruction and chrome reduction processes for further pH adjustment necessary to precipitate heavy metals.

Estimated treatment costs which would be incurred by the plating industry treating to Level I and Level II standards are summarized in Table B-XII. Because these estimates do not include costs required for process modifications to achieve flow reductions assumed for Alternative 2, the small difference in treatment costs for Alternatives 1 and 2 may be misleading; it should be emphasized that the costs given for Alterantive 2 are for the treatment of only 50 percent of the waste flow used as the basis of cost estimates for Alternative 1.

Treatment of Wastewaters Requiring Removal of Heavy Metals

Examination of the characteristics of wastewaters produced by metal processing industries in the Phase I Report revealed that some waste would require removal of various heavy metals to comply with state and federal water quality standards. In addition some of these wastes would require demineralization to meet total dissolved solids criteria. Two process flow diagrams were developed for the treatment of these wastes. Figure 23 illustrates treatment which would be required for effluents containing heavy metals and concentrations of total dissolved solids less than 500 mg/l. Treatment required for wastes containing higher concentrations of total dissolved solids are shown in Figures 24 and 25. These wastes would require demineralization to meet Level I and Level II. Concentration of heavy metals contained in these effluents generally ranged from 1 - 15 mg/l with concentrations of iron ranging upward to 250 mg/l. Many of these wastes contained concentrations of chromium which are in excess of the water quality standards. From the data used to compile the industrial wastewater inventory included in the Phase I report, it was

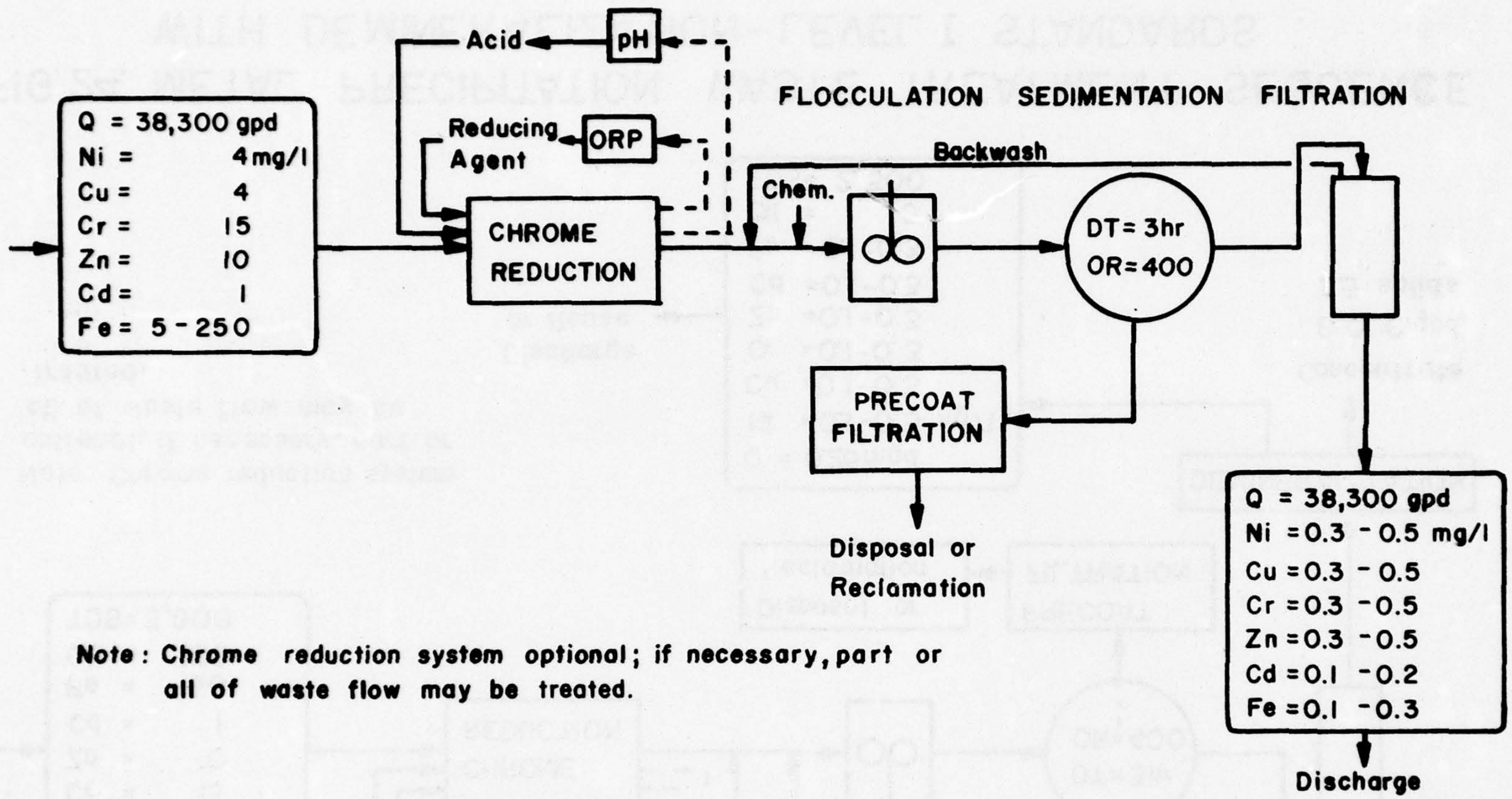

FIG. 23. METAL PRECIPITATION WASTE TREATMENT SEQUENCE WITHOUT DEMINERALIZATION - LEVEL I & II STANDARDS

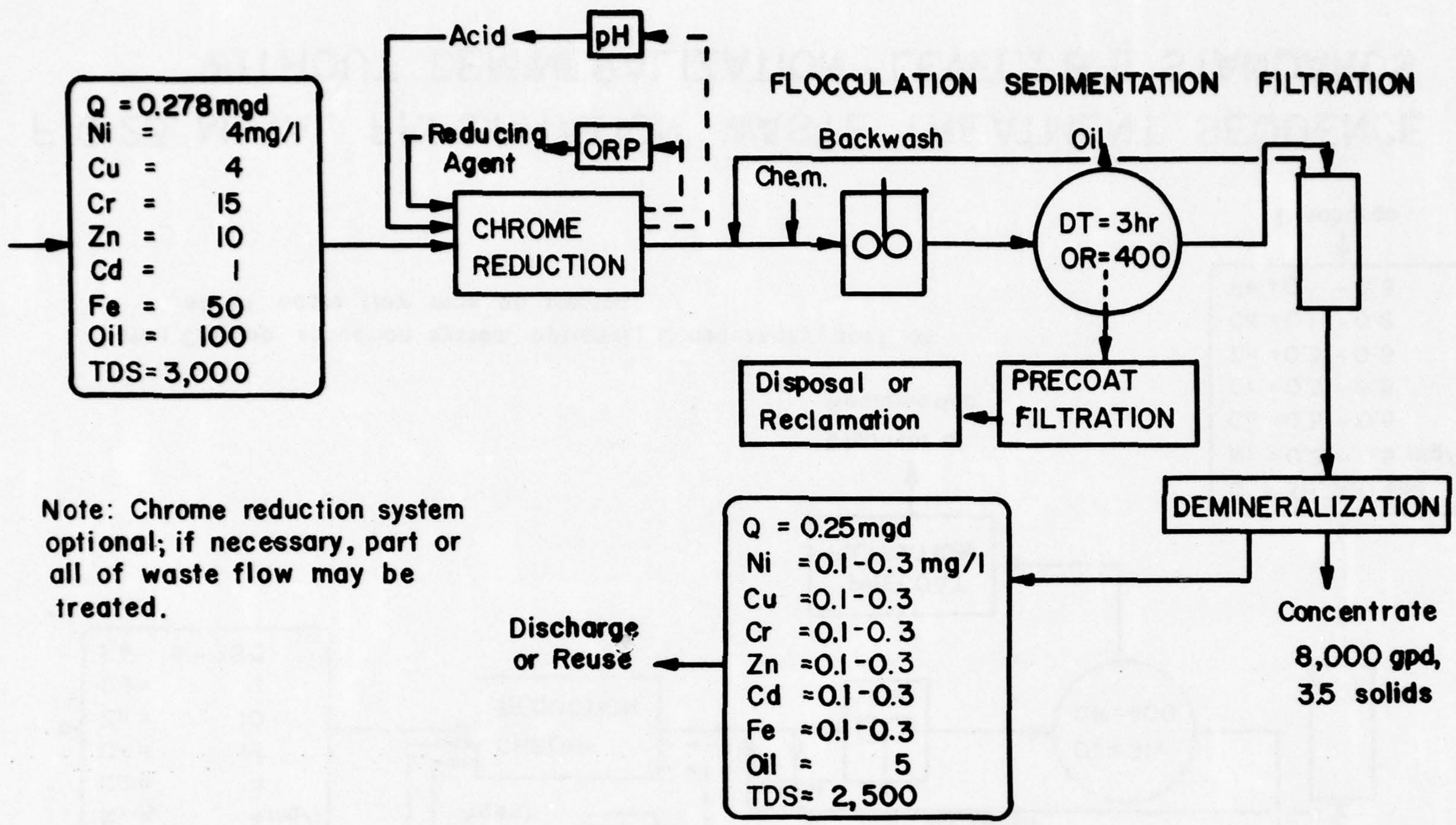

FIG. 24. METAL PRECIPITATION WASTE TREATMENT SEQUENCE WITH DEMINERALIZATION-LEVEL I STANDARDS

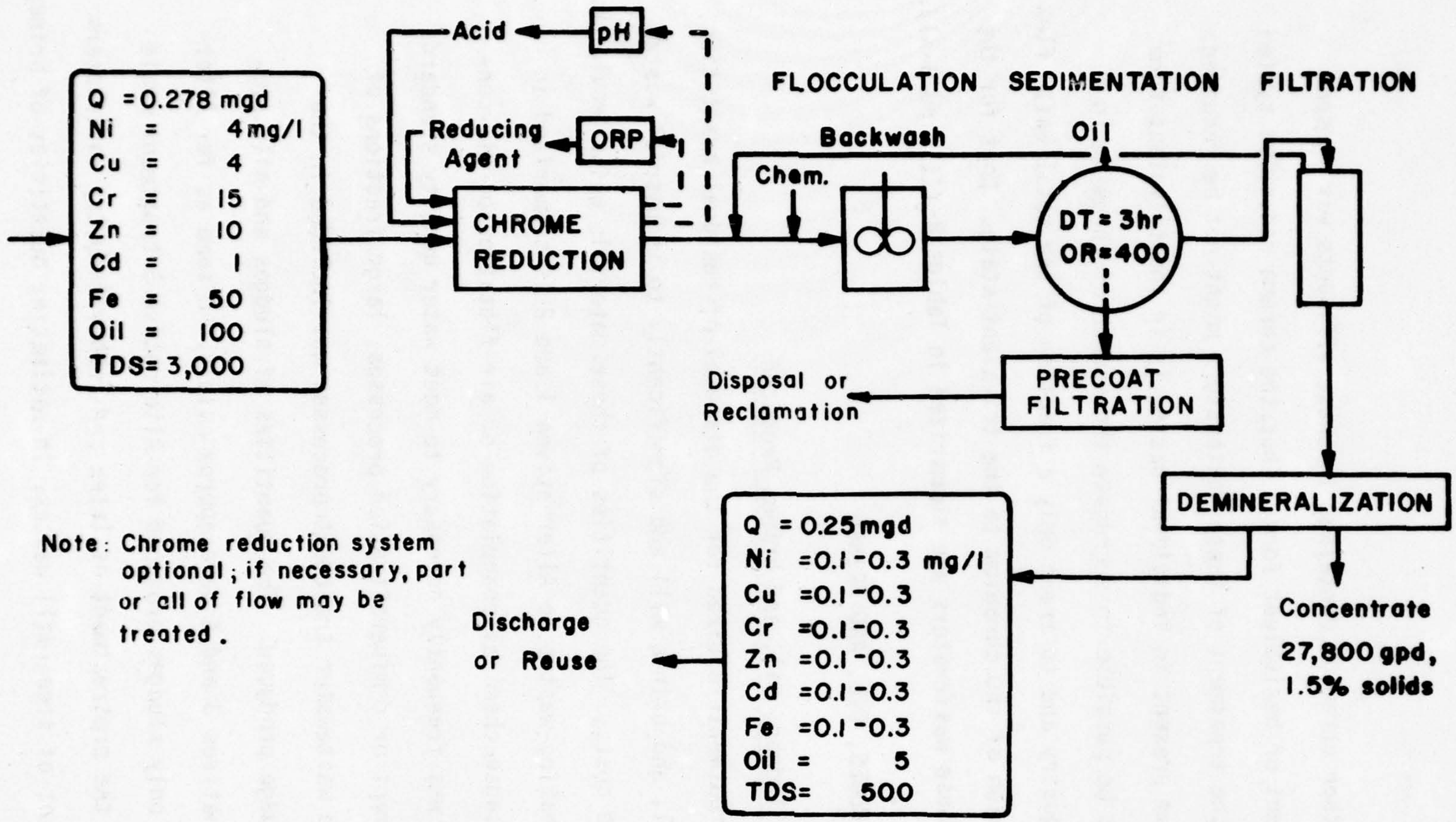

FIG. 25. METAL PRECIPITATION WASTE TREATMENT SEQUENCE WITH DEMINERALIZATION - LEVEL II STANDARDS

not known whether chromium contained in these effluents was present in the trivalent or hexivalent form. Thus, the chrome reduction system included for the treatment of these wastewaters might not be required if the chromium present in individual wastes is in the trivalent form. Also, it might be possible to segregate the source of chromium in a particular industry and to treat only a fraction of the total waste flow for the reduction of the chromium to the trivalent state. Cost for the treatment of these wastewaters are summarized in Tables B-XIII and B-XIV.

HANDLING OF SLUDGES, OIL, AND BRINES

Quantities of Sludges, Oil, and Brines Produced

Chemical treatment required for the disposal of residual quantities of sludges, oil, and brines will add significantly to industrial wastewater treatment costs. The quantities of these materials which would be produced in treating wastes to Alternatives 1 and 2 is summarized in Table II. Because chemical coagulation or air flotation of oil-containing wastes was frequently necessary to meet water quality standards or as pretreatment or demineralization processes, large fractions of oils removed in wastewater treatment processes was included in the quantity of sludge produced. The quantities of sludges and oils produced in Alternatives 3 and 4 were approximately the same as for Alternative 2. The only sludges produced for Alternative 5 treatment would originate from the pretreatment of latex and rubber industry wastewaters and the treatment of steel mill wastes. In estimating quantities of brines

TABLE II

QUANTITIES OF SLUDGES, BRINES, AND OIL

RESULTING FROM TREATMENT OF INDUSTRIAL WASTES

Treatment Alternative	Sludge [a] (dry lb/day)	Oil [b] (lb/day)	Brine (gpd)	Brine (lb solids/day)
1	3,670,000	86,000	270,000	69,000
2	3,690,000	86.000	2,200,000	460,000
3	3,690,000	86,000	3,300,000	500,000
4	3,670,000	86,000	3,300,000	500,000
5	3,600,000	86,000	520,000	79,000

[a] Includes 3,500,000 lb/day of potentially reuseable solids resulting from steel mill processing.
[b] Oil removed by chemical coagulation included in sludge quantities.

which would result from demineralization of wastewaters, it was assumed that brine volume would constitute 10 percent of the feed water flow. Therefore, the estimated quantity of brine produced for Alternative 3 treatment was approximately 33 percent greater than for Alternative 2 treatment, while the quantity of solids resulting after evaporation was slightly greater for Alternative 3 treatment due to the greater water usage assumed by this treatment alternative. Brine produced for Alternative 4 treatment was identical to that produced for Alternative 3 treatment, while the only brine produced for Alternative 5 treatment was due to the demineralization of coke plant wastewaters and pickle rinse water.

Sludge and Oil Disposal Costs

Several firms presently operate in the Cleveland-Akron area which collect waste sludges and oils from industrial operations. Waste materials collected by these firms include dirty lubricating and cutting oils, waste sludges from industrial processing, and waste oils from gasoline stations, in addition to oils and sludges resulting in the treatment of industrial wastewaters. Of the several firms contacted as part of this study, the volume of wastes collected ranged from 6,000 to approximately 15,000 gpd. These firms estimated that most of the material they collected does not originate from wastewater treatment operations. Disposal of sludge-oil mixtures was generally by land filling or lagooning of the semi-liquid mixture, although one firm operated a proprietary process which produced a

solid which was said to be suitable for ultimate disposal to the land. Two firms in or near the Study Area reclaim used oil for reuse as light hydraulic oil, cooling oil, and quench oils. Since most oils accepted for reclaim refining by these firms were originally used for these same purposes, the oil reclamation process is essentially a recycling operation.

Sludge disposal costs estimated in this study included transport of sludges to four centralized collection points located within the Study Area. It was assumed that these collection points would be located so that the average hauling distance from industries in the Study Area would not be greater than 15 miles. For this distance it was assumed that sludge hauling costs would be $6.50/tn which is equivalent to approximately $0.03/gal. It was assumed that all sludges would be dewatered to a solids content of 25 percent prior to hauling to the collection site. Ultimate disposal of sludges was assumed to be by application to strip mined lands located south of the Study Area. This is discussed in detail in the Plan Formulation report. However, further studies should be made regarding the acceptability of oil-laden sludges to the strip mined areas. Sludge disposal costs are summarized in the next chapter, "Total Costs for Wastewater Treatment by Industry." Solids resulting from the treatment of steel mill wastewaters which could be reclaimed were not included in these costs.

<u>Brine Disposal Costs</u>

Costs for the disposal of brine resulting from demineralization

processes were estimated using brine evaporation and deep well injection. Unit costs for these processes are presented in Appendix A. Because of the high costs associated with the transport of brine solutions, it was assumed that brines would be evaporated to dryness by individual industries with subsequent transport of resulting solids to centralized collection points. However, for deep well injection of brines it was necessary to calculate costs based on transport of brine solutions to centralized injection locations. Transport costs of $6.50/tn for evaporated salts and $0.03/gal for brine solutions were assumed in making these estimates.

The centralized collection points and injection sites were assumed to be located such that the average distance from industries to the site would be no greater than 15 miles. For Alternative 1 treatment, little demineralization was required and only two collection or injection sites were included in the cost estimates. All industries required to demineralize wastewaters for Alternative 1 treatment were located near the Cleveland-Akron areas; therefore, collection or injection sites were assumed to be located in these two locations. For Alternatives 2 - 4 demineralization was required in many more industries. Therefore, four collection or injection sites were included in cost estimates of these alternatives. Two additional sites used for these alternatives were assumed to be located at centralized locations in the eastern and western portions of the Study Area.

RECOVERY OF BY-PRODUCTS FROM TREATMENT OPERATIONS

With the implementation of more stringent water quality standards, the recovery of by-products from industrial wastewaters for reuse in manufacturing operations and for reuse as other manufactured materials will become more feasible. The recovery of some materials will become economically attractive as it becomes necessary to remove these materials from wastewaters, while the recovery of other materials will not be feasible until the cost for ultimate disposal of limes and sludges increases relative to the cost of manufactured products. The purpose of this section is to identify by-products which might be feasibly recovered by industries in the Study Area.

Product recovery techniques are presently practiced by a number of industries in the Study Area. Large quantities of flue dust and mill scale particles produced in the production of iron and steel are recovered by processing through sintering plants and returned to blast furnaces. Heavy metals used in the manufacture of some chemical products are recovered by precipitation and concentration techniques where the concentration of the metal is large compared to impurities in the wastestream. Oils used in manufacturing processes are currently reclaimed by industry in the Study Area and by refineries which specialize in oil reclamation. Skim oil removed from wastewater at the Ford Motor Company engine plant in Cleveland is processed for reuse [28]. Oils produced by reclaim refineries are primarily cutting, quench, and lubricating oils for industrial use.

Materials which may be recovered in the by-products coking process include phenols, ammonia, napthalene, benzene, xylene, cresols, and tars.

The quantity of products recovered usually depends upon the market for these materials compared to disposal costs. In the meat and poultry processing industries, many waste materials are routinely shipped to rendering plants.

Product recovery techniques which might become feasible with the implementation of more stringent water quality standards include the recovery of heavy metals from plating rinse waters. However, metal recovery would be feasible principally in large metal finishing industries or in electroplating industries which use only one or two metals in manufacturing processes. Using the most common concentration techniques such as ion exchange, evaporation, and reverse osmosis, a separate treatment and recovery system must be installed for each wastestream. Thus, recovery of metals would probably not be economically feasible for small metal finishing industries which use a variety of metals in manufacturing processes. Because of the large number of small metal finishing industries located in the Study Area, heavy metal recovery techniques were not included in the design examples presented in this study; however, in complying with proposed state and federal water quality standards, large industries might find metal recovery techniques to be the least expensive type of wastewater treatment. It is also possible that the metals might be reclaimed from sludges produced in the precipitation of wastes containing a variety of metals. It is estimated that approximately 10,000 lbs/day of copper, chromium, cadmium, zinc, and nickel would be removed from waste rinse waters in the electroplating industry in the Study Area if the proposed water quality standards were

implemented. Separation and recovery of these metals using molten salt techniques or other technology presently used in the separation of ores might be possible, but further study of these methods would be required.

Disposal of sludges produced in industrial waste treatment processes could probably most efficiently be accomplished by applying these sludges along with sludges resulting from the treatment of municipal wastewaters to strip mined lands located to the South of the Study Area. However, sludges produced in the treatment of coke plant wastes might most effectively be returned to the coking furnaces for incineration. Likewise, if lime were used for precipitation and neutralization of other wastewaters resulting from steel mill operations, these sludges might be effectively utilized as flux in blast furnaces. Soluble oils removed from wastewaters by chemical coagulation and precipitation methods might be released from the resulting sludge by further chemical treatment. It might also be possible to recover and recycle chemicals used for the destabilization of oil emulsions. However, further chemical treatment of oil-laden sludges might add to the quantity of total dissolved solids which must be removed from wastestreams to achieve proposed federal water quality criteria.

The disposal of brine resulting from demineralization of wastewaters poses a particularly difficult problem. Disposal methods which have been proposed including ocean discharge, solar evaporation, and dumping in arid areas [29] were not considered because of the location of the Study Area. In fact, the high solubility of these materials which makes their

removal from wastewater so difficult is also the principal problem in the disposal of these solids. Land disposal of either brine solutions or evaporated salts could not be considered in the Cleveland-Akron area since these substances would readily re-enter the water cycle, thus only transferring the total dissolved solids load from one area to another. At the present time, the only methods which may be offered for the disposal of brines are deep well injection or evaporation followed by containment of the salt residues in non-porous geological formations or man-made containment vessels. Following evaporation, it might be possible to utilize these salt residues as road salts in other areas; however, this is another instance of transferring a waste problem from one area to another. Because of the great expense both in removing total dissolved solids from wastewaters and in properly disposing of the resulting residues, the environmental impact of reducing total dissolved solids loads from wastewaters in the Cleveland-Akron area should be closely examined before implementing these standards.

TOTAL COST FOR WASTEWATER TREATMENT BY INDUSTRY

Treatment costs for the design example plants discussed in the preceeding chapter were used as a basis for the estimation of the total industrial treatment costs. Construction costs for different sized treatment facilities were calculated by assuming that the cost varied with the ratio of plant design capacity raised to the 0.6 power using the cost of the design example for each treatment facility as the basis for calculation. Likewise, operation and maintenance costs were calculated assuming that these costs varied as the ratio of the design capacities raised to the 0.85 power. Details of these calculations are contained in the chapter entitled "Design and Cost Methodology." In this chapter the total costs incurred for treatment of industrial wastewaters are presented in summary form. Costs given for each treatment sequence include the total estimated cost required for the construction and operation of these facilities over the fifty year period covered by the wastewater management program. It should be emphasized that these costs include treatment of wastes required by major industries in the Study Area, but do not include treatment which would be required for all industrial wastes. Additional industrial wastes which would most likely require treatment for compliance with the water quality criteria assumed in this study are discussed in the chapter entitled "Design and Cost Methodology." Costs summarized in this chapter include provisions for the treatment of incompatible wastes which would be discharged

directly to receiving waters and for pretreatment of other wastes required before discharge to muncipal sewer systems. Costs allocable to industry for the treatment of industrial wastes in combined muncipal-industrial treatment facilities will be examined in Phase III of this study.

Summaries of the total costs for construction and operation of industrial waste treatment facilities excluding costs for final sludge and brin disposal are summarized in Tables III - VII. Shown in these tables are the total original capital costs for all treatment facilities, annual operation and maintenance costs, and total costs incurred over the life of the project has replacement of equipment. Costs are presented on a present worth basis for interest rates of 5-3/8, 7, and 10%. From these summaries it is evident that major costs would be borne by the steel and electroplating industries.

In many cases differences in costs incurred for treatment to Level I Level II were due to limitations on total dissolved solids concentrations required for Level II standards. The relatively small difference in the total costs incurred by all industries between the two standards is the result of the large fraction of total treatment costs born by industries which either do not require demineralization for either water quality standard or which require demineralization for the achievement for both water quality standards. The impact of demineralization requirements becomes evident upon comparing treatment costs for the inorganic chemicals and rubber products industries. In these industries costs required

TABLE III

SUMMARY OF INDUSTRIAL WASTEWATER TREATMENT

COSTS FOR ALTERNATIVE 1

Industry	Original Capital Cost ($)	Annual O&M Cost ($/yr)	5 3/8% P.W. Total Cost[a] ($)	7% P.W. Total Cost[a] ($)	10% P.W. Total Cost[a] ($)
SIC 28 Inorganic Chemicals	1,833,000	243,000	6,241,000	5,190,000	4,209,000
SIC 28 Latex Production	1,080,000	128,000	3,534,000	2,935,000	2,400,000
SIC 30 Rubber Products	4,903,000	792,000	20,339,000	16,622,000	13,158,000
SIC 3312 Steel Production					
Coke Plants	1,979,100	246,000	6,767,000	5,615,000	4,492,000
Blast Furnaces	6,848,000	764,000	18,528,000	14,903,000	15,291,000
Steel Furnaces	2,525,000	585,000	11,898,000	9,584,000	7,426,000
Hot Rolling Mills	66,119,000	7,376,000	201,648,000	171,581,000	140,002,000
Cold Rolling Mills	22,189,000	1,216,000	53,151,000	53,106,000	35,102,000
Pickle Rinse	1,712,000	415,000	9,157,000	7,400,000	5,753,000
SIC 29,33,34,35,36,37 Industries Requiring Removal of Oil, Metals, and TDS					
Oil Removal, Moderate TDS	104,000	51,000	1,000,000	791,000	595,000
Oil Removal, High TDS	17,902,000	1,432,000	46,135,000	39,529,000	20,676,000
Plating and Coating	44,246,000	5,490,000	145,728,000	121,223,000	98,464,000
Metal Removal without Demineralization	21,820,000	2,596,000	72,023,000	59,890,000	48,667,000
Metal Removal with Demineralization	11,929,000	1,500,000	40,018,000	33,212,000	26,880,000
Totals	204,600,000	21,700,000	626,000,000	527,000,000	533,000,000

[a] Sum of original capital cost, present worth of replacement costs, and present worth of operation and maintenance costs.

TABLE IV

SUMMARY OF INDUSTRIAL WASTEWATER TREATMENT

COSTS FOR ALTERNATIVE 2

Industry	Original Capital Cost ($)	Annual O&M Cost ($/yr)	5 3/8% P.W. Total Cost[a] ($)	7% P.W. Total Cost[a] ($)	10% P.W. Total Cost[a] ($)
SIC 28 Inorganic Chemicals	5,488,000	819,000	20,863,000	17,262,000	13,753,000
SIC 28 Latex Production	1,546,000	147,000	4,478,000	3,749,000	3,074,000
SIC 30 Rubber Products	9,631,000	1,608,000	39,494,000	32,310,000	37,353,000
SIC 3312 Steel Production					
Coke Plants	2,348,000	358,000	9,655,000	7,390,000	6,341,000
Blast Furnaces	8,576,000	1,237,000	32,106,000	21,378,000	21,077,000
Steel Furnaces	1,975,000	533,000	11,506,000	9,260,000	7,160,000
Hot Rolling Mills	78,787,000	9,462,000	257,046,000	213,595,000	173,357,000
Cold Rolling Mills	22,189,000	1,216,000	53,151,000	53,106,000	35,102,000
Pickle Rinse	3,380,000	624,000	15,101,000	12,275,000	9,639,000
SIC 29,33,34,35,36,37 Industries Requiring Removal of Oil, Metals, and TDS					
Oil Removal, Moderate TDS	6,034,000	708,000	20,097,000	16,045,000	13,243,000
Oil Removal, High TDS	20,438,000	1,631,000	53,568,000	25,260,000	37,001,000
Plating and Coating	47,519,000	5,823,000	157,740,000	130,816,000	105,937,000
Metal Removal without Demineralization	21,820,000	2,596,000	72,023,000	59,891,000	48,667,000
Metal Removal with Demineralization	17,073,000	2,042,000	55,064,000	45,122,000	37,777,000
Totals	247,000,000	27,400,000	791,500,000	657,400,000	535,000,000

[a] Sum of original capital cost, present worth of replacement costs, and present worth of operation and maintenance costs.

TABLE V

SUMMARY OF INDUSTRIAL WASTEWATER TREATMENT

COSTS FOR ALTERNATIVE 3

Industry	Original Capital Cost ($)	Annual O&M Cost ($/yr)	5 3/8% P.W. Total Cost[a] ($)	7% P.W. Total Cost[a] ($)	10% P.W. Total Cost[a] ($)
SIC 28 Inorganic Chemicals	5,488,000	819,000	20,863,000	17,262,000	13,753,000
SIC 28 Latex Production	1,546,000	140,000	4,478,000	3,749,000	3,074,000
SIC 30 Rubber Products	9,631,000	1,608,000	39,494,000	32,310,000	37,353,000
SIC 3312 Steel Production					
Coke Plants	2,535,000	366,000	9,655,000	7,941,000	6,341,000
Blast Furnaces	15,487,000	2,447,000	63,551,000	51,934,000	41,124,000
Steel Furnaces	2,692,000	572,000	13,451,000	10,897,000	8,517,000
Hot Rolling Mills	78,787,000	9,051,000	257,046,000	213,595,000	173,352,000
Cold Rolling Mills	22,189,000	895,000	42,724,000	37,306,000	32,392,000
Pickle Rinse	6,673,000	1,113,000	28,673,000	23,353,000	18,395,000
SIC 29,33,34,35,36,37 Industries Requiring Removal of Oil, Metals, and TDS					
Oil Removal, Moderate TDS	6,034,000	677,000	20,097,000	16,045,000	13,243,000
Oil Removal, High TDS	20,438,000	1,560,000	53,568,000	45,260,000	37,001,000
Plating and Coating	71,637,000	9,483,000	257,894,000	212,987,000	170,781,000
Metal Removal without Demineralization	21,820,000	2,597,000	72,023,000	59,891,000	48,667,000
Metal Removal with Demineralization	17,073,000	1,953,000	55,064,000	45,122,000	37,777,000
Totals	282,000,000	33,200,000	938,600,000	777,700,000	641,800,000

[a]Sum of original capital cost, present worth of replacement costs, and present worth of operation and maintenance costs.

TABLE VI

SUMMARY OF INDUSTRIAL WASTEWATER TREATMENT

COSTS FOR ALTERNATIVE 4

Industry	Original Capital Cost ($)	Annual O&M Cost ($/yr)	5 3/8% P.W. Total Cost[a] ($)	7% P.W. Total Cost[a] ($)	10% P.W. Total Cost[a] ($)
SIC 28 Inorganic Chemicals	5,488,000	819,000	20,863,000	17,262,000	13,753,000
SIC 28 Latex Production	1,546,000	140,000	4,478,000	3,749,000	3,074,000
SIC 30 Rubber Products	9,631,000	1,608,000	39,494,000	32,310,000	37,353,000
SIC 3312 Steel Production					
Coke Plants	2,535,000	366,000	9,655,000	7,941,000	6,341,000
Blast Furnaces	15,487,000	2,447,000	63,551,000	51,934,000	41,124,000
Steel Furnaces	2,692,000	572,000	13,451,000	10,897,000	8,517,000
Hot Rolling Mills	78,787,000	9,051,000	257,046,000	213,595,000	173,352,000
Cold Rolling Mills	22,189,000	895,000	42,724,000	37,306,000	32,392,000
Pickle Rinse	6,673,000	1,113,000	28,673,000	23,353,000	18,395,000
SIC 29,33,34,35,36,37 Industries Requiring Removal of Oil, Metals, and TDS					
Oil Removal, Moderate TDS	6,034,000	677,000	20,097,000	16,045,000	13,243,000
Oil Removal, High TDS	20,438,000	1,560,000	53,568,000	45,260,000	37,001,000
Plating and Coating	71,637,000	9,483,000	257,894,000	212,987,000	170,781,000
Metal Removal without Demineralization	5,221,000	798,000	20,337,000	16,712,000	13,343,000
Metal Removal with Demineralization	17,073,000	1,953,000	55,064,000	45,122,000	37,777,000
Totals	265,400,000	31,400,000	886,900,000	734,500,000	606,400,000

[a] Sum of original capital cost, present worth of replacement costs, and present worth of operation and maintenance costs.

TABLE VII

SUMMARY OF INDUSTRIAL WASTEWATER TREATMENT

COSTS FOR ALTERNATIVE 5

Industry	Original Capital Cost ($)	Annual O&M Cost ($/yr)	5 3/8% P.W. Total Cost[a] ($)	7% P.W. Total Cost[a] ($)	10% P.W. Total Cost[a] ($)
SIC 28 Inorganic Chemicals	533,000	154,000	3,341,000	2,688,000	2,075,000
SIC 28 Latex Production	111,000	32,000	710,000	570,000	438,000
SIC 30 Rubber Products	2,867,000	555,000	13,112,000	10,700,000	8,439,000
SIC 3312 Steel Production					
Coke Plants	2,535,000	366,000	9,655,000	7,942,000	6,341,000
Blast Furnaces	15,487,000	2,447,000	63,550,000	51,934,000	41,124,000
Steel Furnaces	2,692,000	572,000	13,450,000	10,896,000	8,517,000
Hot Rolling Mills	78,787,000	9,051,000	257,046,000	213,595,000	173,352,000
Cold Rolling Mills	22,189,000	895,000	42,724,000	37,306,000	32,394,000
Pickle Rinse	6,673,000	1,113,000	28,674,000	23,353,000	18,395,000
SIC 29,33,34,35,36,37 Industries Requiring Removal of Oil, Metals, and TDS					
Oil Removal, Moderate TDS	100,000	50,000	600,000	791,000	1,000,000
Oil Removal, High TDS	927,000	131,000	3,460,000	2,851,000	2,284,000
Plating and Coating	13,438,000	3,584,000	59,697,000	64,102,000	49,525,000
Metal Removal without Demineralization	5,221,000	798,000	20,337,000	16,712,000	13,343,000
Metal Removal with Demineralization	1,931,000	168,000	5,241,000	4,423,000	3,680,000
Totals	153,500,000	19,900,000	541,800,000	447,900,000	360,900,000

[a] Sum of original capital cost, present worth of replacement costs, and present worth of operation and maintenance costs.

to achieve Alternative 2 are from 200 to 300% greater than costs required to treat to Alternative 1 levels.

Power and labor requirements for industrial wastewater treatment facilities are summarized in Table VIII. Because the cost models used in this study frequently do not identify individual factors comprising total operation and maintenance costs, only very general estimates of power and labor requirements could be made. After identifying the fraction of operation and maintenance costs allocable to labor and power, quantities of these items were calculated using unit costs of $0.015/kwh and $4.80/hr for power and labor, respectively. Because gas or oil would be used as the energy source for evaporation units, no power requirements for these processes were included although small amounts of electrical energy might be required for miscellaneous uses.

The quantity of chemicals required for industrial wastewater treatment is summarized in Table IX. These quantities are only general estimates because of the difficulty of determining chemical requirements without more detailed characterization of the wastestreams involved.

A summary of total costs required for the various treatment levels including sludge and brine handling are show in Tables X - XIV, respectively. Values listed as "Treatment Costs" in these tables include 1) the original cost of all process facilities required to meet the respective water quality standards including allowances for nominal piping between treatment processes, site preparation, engineering, and administration, and a contingencey allowance; 2) replacement costs for unit processes as required over the life of the project; and 3) operation and maintenance costs including labor, chemicals, materials, and power.

TABLE VIII

POWER AND LABOR REQUIREMENTS FOR INDUSTRIAL WASTE TREATMENT[a]

	Alternative 1			Alternative 2			Alternative 3			Alternative 4			Alternative 5		
	Power	Labor		Power	Labor		Power	Labor		Power	Labor		Power	Labor	
	Mw	$\frac{\text{man-hr}}{\text{yr}} \times 10^{-3}$	F.T.J.E.[b]	Mw	$\frac{\text{man-hr}}{\text{yr}} \times 10^{-3}$	F.T.J.E.[b]	Mw	$\frac{\text{man-hr}}{\text{yr}} \times 10^{-3}$	F.T.J.E.[b]	Mw	$\frac{\text{man-hr}}{\text{yr}} \times 10^{-3}$	F.T.J.E.[b]	Mw	$\frac{\text{man-hr}}{\text{yr}} \times 10^{-3}$	F.T.J.E.[b]
Treatment of Main wastestream	20	1600	800	40	1700	850	50	1800	900	50	1700	850	30	1400	700
Evaporation of Brines	c	100	50	c	300	170	c	400	200	c	400	200	c	20	11
Deep Well Injection of Brines	2	4	2	-	13	7	2	13	7	2	13	7	1	4	2

[a] Labor requirements for transport of sludges, oil, and brine not included.

[b] Full time job equivalent.

[c] Power obtained from gas and oil.

TABLE IX

CHEMICAL REQUIREMENTS FOR

INDUSTRIAL WASTE TREATMENT[a]

Chemical	Quantity(tn/yr)
Lime	90,000
Alum	3,000
Polyetectrolyte	200
Filter Precoat	3,000
Diatomaceous Earth	4,000
Chlorine	2,000
Caustic	3,000
Sulfur Dioxide	1,000
Phosphorus	50
Clay	200

[a]Quantities estimated are for Alternative 2 treatment.

TABLE X

INDUSTRIAL WASTEWATER TREATMENT COST SUMMARY

FOR ALTERNATIVE 1

Item	Capital Cost (1972 $ x 10^{-6})	O & M Cost (1972 $/yr x 10^{-6})	Present Worth (1972 $ x 10^{-6}) 5 3/8% Interest Replacement Cost	5 3/8% Interest O & M Cost	5 3/8% Interest Total Cost[a]	7 % Interest Replacement Cost	7 % Interest O & M Cost	7 % Interest Total Cost[a]	10 % Interest Replacement Cost	10 % Interest O & M Cost	10 % Interest Total Cost[a]
Treatment Costs	204.6	21.7	33.8	386.9	626.0	23.8	298.9	527.4	11.9	216.0	533.0
Sludge Disposal	-	1.2	-	20.9	20.9	-	16.1	16.1	-	11.6	11.6
Brine Treatment by Evaporation	8.6	0.9	3.0	16.4	27.9	1.9	12.6	23.1	1.0	9.0	18.7
Brine Treatment by Deep Well Injection	0.6	1.9	0.06	34.5	35.2	0.04	26.6	27.2	0.02	19.1	19.7
Total Project Costs Using Brine Evaporation	213.2	23.8	-	-	674.8	-	-	566.6	-	-	463.2
Total Project Costs Using Deep Well Injection of Brine	205.2	24.8	-	-	682.1	-	-	570.7	-	-	464.3

[a] Total cost is the sum of capital costs, present worth replacement costs, and present worth operation and maintenance costs.

TABLE XI

INDUSTRIAL WASTEWATER TREATMENT COST SUMMARY

FOR ALTERNATIVE 2

Item	Capital Cost (1972 $ x 10^{-6})	O & M Cost (1972 $/yr x 10^{-6})	Present Worth (1972 $ x 10^{-6}) 5 3/8% Interest Replacement Cost	5 3/8% Interest O & M Cost	5 3/8% Interest Total Cost[a]	7 % Interest Replacement Cost	7 % Interest O & M Cost	7 % Interest Total Cost[a]	10 % Interest Replacement Cost	10 % Interest O & M Cost	10 % Interest Total Cost[a]
Treatment Costs	247.0	27.4	53.0	491.5	791.5	32.0	378.4	652.4	16.1	271.9	535.0
Sludge Disposal	-	1.2	-	21.6	21.6	-	16.7	16.7	-	12.0	12.0
Brine Treatment by Evaporation	28.7	3.5	10.0	62.7	101.4	6.4	48.3	83.4	3.4	34.7	66.8
Brine Treatment by Deep Well Injection	1.4	23.2	0.1	415.9	417.5	0.09	320.2	321.7	0.04	230.0	231.5
Total Project Costs Using Brine Evaporation	275.7	32.1	-	-	914.5	-	-	752.5	-	-	613.8
Total Project Costs Using Deep Well Injection of Brine	248.4	51.8	-	-	1,230.6	-	-	990.8	-	-	778.5

[a]Total cost is the sum of capital costs, present worth replacement costs, and present worth operation and maintenance costs.

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TABLE XII

INDUSTRIAL WASTEWATER TREATMENT COST SUMMARY

FOR ALTERNATIVE 3

Item	Capital Cost (1972 \$ x 10^{-6})	O & M Cost (1972 \$/yr x 10^{-6})	Present Worth (1972 \$ x 10^{-6}) 5 3/8% Interest Replacement Cost	5 3/8% Interest O & M Cost	5 3/8% Interest Total Cost[a]	7 % Interest Replacement Cost	7 % Interest O & M Cost	7 % Interest Total Cost[a]	10 % Interest Replacement Cost	10 % Interest O & M Cost	10 % Interest Total Cost[a]
Treatment Costs	282.0	33.2	64.0	594.6	938.6	37.7	458.6	777.7	19.1	341.0	642.0
Sludge Disposal		1.2	-	21.6	21.6	-	16.7	16.7	-	12.0	12.0
Brine Treatment by Evaporation	35.4	4.0	12.3	72.2	119.9	7.9	55.6	98.9	4.2	9.9	79.4
Brine Treatment by Deep Well Injection	2.2	35.7	0.2	640.0	642.3	0.1	492.9	495.2	0.07	354.1	356.3
Total Project Costs Using Brine Evaporation	317.4	38.4	-	-	1080.1	-	-	893.3	-	-	733.4
Total Project Costs Using Deep Well Injection of Brine	284.2	70.1	-	-	1,602.5	-	-	1,289.6	-	-	1,010.3

[a]Total cost is the sum of capital costs, present worth replacement costs, and present worth operation and maintenance costs.

TABLE XIII

INDUSTRIAL WASTEWATER TREATMENT COST SUMMARY

FOR ALTERNATIVE 4

Item	Capital Cost (1972 \$ x 10^{-6})	O & M Cost (1972 \$/yr x 10^{-6})	Present Worth (1972 \$ x 10^{-6})								
			5 3/8% Interest			7 % Interest			10 % Interest		
			Replacement Cost	O & M Cost	Total Cost[a]	Replacement Cost	O & M Cost	Total Cost[a]	Replacement Cost	O & M Cost	Total Cost[a]
Treatment Costs	265.4	31.4	59.1	562.4	886.9	35.9	433.1	734.5	18.3	322.7	606.4
Sludge Disposal	-	1.1	-	19.8	19.8	-	15.3	15.3	-	11.0	11.0
Brine Treatment by Evaporation	35.4	4.0	12.3	72.2	119.9	7.9	55.6	98.9	4.2	39.9	79.4
Brine Treatment by Deep Well Injection	2.2	35.7	0.2	640.0	642.3	0.1	492.9	495.2	0.07	354.1	356.3
Total Project Costs Using Brine Evaporation	300.8	36.5	-	-	1,026.6	-	-	848.7	-	-	696.8
Total Project Costs Using Deep Well Injection of Brine	267.6	68.2	-	-	1,549.0	-	-	1,245.0	-	-	973.7

[a]Total cost is the sum of capital costs, present worth replacement costs, and present worth operation and maintenance costs.

TABLE XIV

INDUSTRIAL WASTEWATER TREATMENT COST SUMMARY

FOR ALTERNATIVE 5

Item	Capital Cost (1972 $ x 10^{-6})	O & M Cost (1972 $/yr x 10^{-6})	Present Worth (1972 $ x 10^{-6}) 5 3/8% Interest Replacement Cost	5 3/8% Interest O & M Cost	5 3/8% Interest Total Cost[a]	7 % Interest Replacement Cost	7 % Interest O & M Cost	7 % Interest Total Cost[a]	10 % Interest Replacement Cost	10 % Interest O & M Cost	10 % Interest Total Cost[a]
Treatment Costs	153.5	19.9	31.[illegible]	[illegible]	541.8	19.6	274.8	447.9	9.5	197.8	360.9
Sludge Disposal	-	0.1	-	[illegible]	2.1	-	1.6	1.6	-	1.1	1.1
Brine Treatment by Evaporation	2.3	0.3	0.9	5.4	8.6	0.6	4.1	7.0	0.3	3.0	5.6
Brine Treatment by Deep Well Injection	0.3	2.4	0.03	42.0	42.3	0.02	30.0	30.3	0.009	24.0	24.3
Total Project Costs Using Brine Evaporation	155.8	20.3	-	-	552.5	-	-	456.5	-	-	367.6
Total Project Costs Using Deep Well Injection of Brine	153.8	22.4	-	-	586.2	-	-	479.8	-	-	386.3

[a] Total cost is the sum of capital costs, present worth replacement costs, and present worth operation and maintenance costs.

Items which are not included in the costs listed in Tables IX-XIII include treatment of cooling waters which may be required to meet temperature standards, treatment of cooling waters which may be required if maximum in-plant reuse of water is practiced by industry, extraordinary piping costs required to bring waste from various processing areas to centralized treatment units, and piping and process changes required for reductions in water usage for water reuse. In addition, it should be emphasized that treatment costs given in these tables cover only the stipulated treatment costs for major industries in the Study Area. Additional treatment would no doubt be required by smaller industries. In many cases, adequate wastewater characterization data from all industries is not presently available to evaluate treatment processes required for compliance with proposed state and federal water quality criteria. A principal example relates to the identification of TDS concentrations of industrial wastewaters resulting from the discharge of spent regenerants from ion exchange demineralization processes used to prepare boiler feed water. Treatment of these wastes by industry would be required for compliance with TDS limitations.

In some instances, treatment costs for Alternative 2 were estimated based on reduced waste volumes which would result from reductions of in-plant use of water in manufacturing processes. The total cost incurred by these industries for water pollution control will be heavily dependent on costs required for in-plant modifications required to reduce water usage in the manufacturing processes. The total cost of water used by

a given industry may be calculated according to the following relationship:

Total Cost = Cost of water + in-plant waste treatment costs + industrial waste treatment costs for discharge to municipal sewer systems.

The incentive for an industry to reduce water usage in manufacturing processes and to implement reuse of wastewaters will depend on the relationship of the total treatment cost to the cost required for modifications of plant equipment to achieve water usage reductions and wastewater reuse. In general, it can be stated that a given industry will implement wastewater reduction techniques if:

Cost of modifications required for reuse $\leq$ savings of total water and waste treatment cost due to flow reduction.

In order to identify the reductions in waste treatment costs which would be achieved by reducing in-plant use of water assumed for Alternative 2, industrial wastewater treatment costs were calculated assuming only nominal reductions of water usage. These costs have been referred to as Alternative 3. Using Alternative 2 and Alternative 3 treatment costs for various industries along with costs for the purchase of water and for the discharge of wastewater to municipal sewer systems, a total water and waste water treatment cost for a particular industry could be calculated. It could then be assumed that industry would implement water conservation techniques if the cost of implementing such techniques were less than the

savings of total water and wastewater treatment costs which could be realized.

TREATMENT OF COOLING WATERS

As mentioned above, the treatment of cooling water has not been considered in the study. It has been assumed that cooling flows from once-through cooling systems would be uncontaminated and could be discharged to municipal sewer systems or to receiving waters without treatment. However, in some industries a sizeable investment might be required to segregate cooling flows from process or contaminated waste flows and to eliminate the contamination of cooling water from miscellaneous sources such as leaks and cooling coils. If cooling water is recycled by industry, it is usually necessasry to add chemical agents to prevent build-up of algal growth and slimes in pipes and cooling towers. Because of the bactericidal nature of these chemicals, it would probably be necessary to remove these substances prior to discharge to municipal sewer systems or to waterways. If chromates are used as bactericidal agents in cooling waters, the chromium concentration will be approximately 15 - 20 mg/l. This would have to be removed by appropriate pretreatment. If organic bactericides are used, some of these substances in small concentrations might be removed in biological treatment units of municipal treatment facilities. However, it might be necessary to pretreat cooling waters containing other organic bactericides.

POTENTIAL COMBINED INDUSTRIAL WASTE TREATMENT FACILITIES

In this section, three schemes for the treatment and utilization of industrial wastes are discussed. The feasibility of these plans including estimates of the cost required for the implementation of the plans are discussed. The plans presented are capable of being incorporated into any of the water-based regional wastewater management alternatives developed for the Study Area.

WASTEWATER REUSE IN THE STEEL INDUSTRY

In 1968, the Ohio Water Development Authority commissioned Battelle Memorial Institute to study the feasibility of several projects for water pollution abatement and water quality improvement on the lower Cuyahoga River [30]. The major project involved the reuse of effluent from the Cleveland Southerly treatment facility for process water in the Cleveland steel mills. Specifically, this plan provided for construction of an OWDA facility that would:

1. Accept secondary effluent from the Southerly treatment plant.
2. Provide further treatment of this effluent as required for use as process water in the three Cleveland steel mills.
3. Accept the return process flow from the steel mills for final treatment and discharge to the river.

Advantages claimed for this plan were that the City of Cleveland would no longer need to install advanced treatment processes at the

Southerly plant, that the plan would provide a better quality process water to the steel companies than available from the river, and that implementation of the plan would avoid the necessity for each steel mill to treat its own waste.

The system recommended by Battelle is shown in Figure 26. The OWDA facility would receive 95 mgd from the Southerly treatment plant. Treatment provided in this facility included chlorination and an alternate plan providing for additional suspended solids removal. The 100 mgd estimated demand for use in the steel mills was provided by recycle of 5 mgd within the OWDA plant. Transport of effluent, raw water, and waste streams was assumed to be by pipeline. The site chosen for the OWDA plant was a 50-acre piece of land located along the river between the steel mills and the Southerly plant.

Costs for this project were estimated to be $18,800,000 without additional suspended solids removal of the Southerly effluent and $28,300,000 when suspended solids removal facilities were included. These values compared to an estimated $41,000,000 for the construction of separate facilities by the steel companies without OWDA financing. On the basis of water volume treated, costs of the OWDA plant would be $0.132/1000 gal and $0.174/1000 gal for facilities without and with additional suspended solids removal processes, respectively.

Final treatment of process water from the steel mills at the OWDA facility included in the cost estimates were "equivalent to tertiary treatment" including removal of phosphorus, suspended solids, and oil.

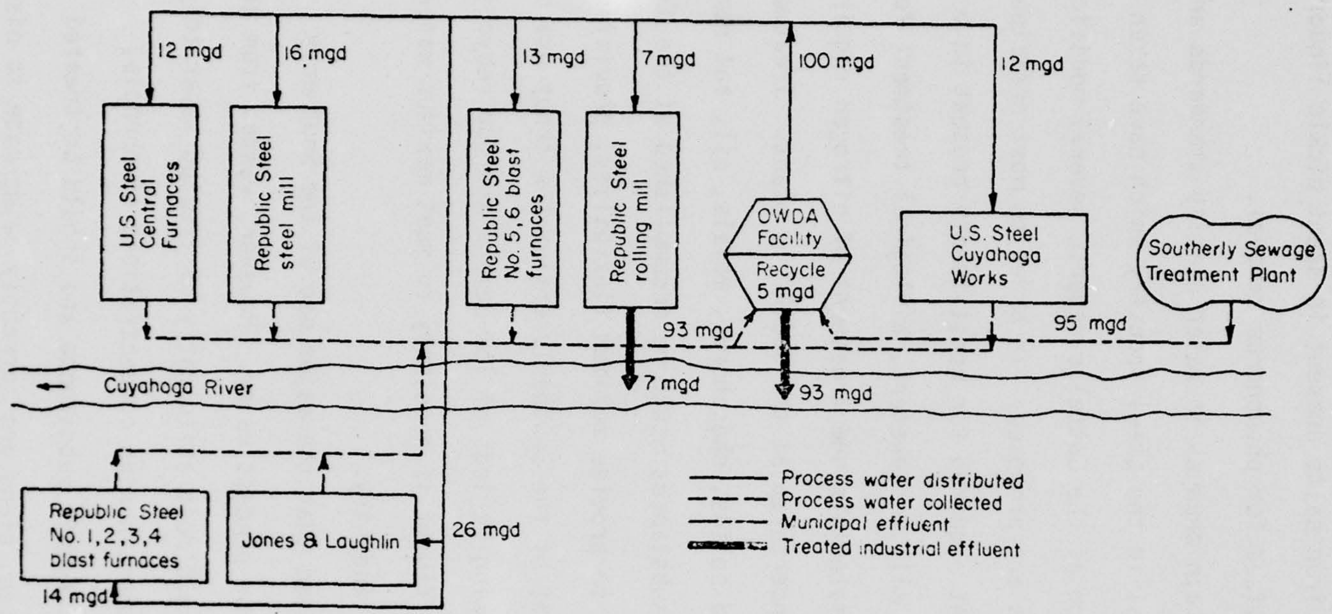


FIG. 26. SCHEMATIC DIAGRAM FOR WASTEWATER REUSE IN CLEVELAND STEEL MILLS - FROM BUTRICO et al [30].

It was assumed that iron salts present in spent pickle liquors and rinses could be utilized for phosphorus removal.

In view of certain changes in water quality standards and plans for pollution control in the steel industry which have taken place since the publication of the Battelle report, several modifications of the original plan are proposed. In order to most efficiently provide the treatment required for constituents present in both municipal and steel mill wastewaters, biological treatment for the removal of organic materials and treatment of nitrogen required substances should be undertaken at the Southerly plant. Treatment for the removal of suspended solids, phosphorus, metals, oil, and removal of refractory organic substances would be accomplished at the OWDA facility. In order to provide maximum flexibility, provisions should be made for treatment of the Southerly effluent without use by the steel industries during periods of low demand and for recycling of the OWDA facility effluent if necessary to meet maximum water requirements for the steel industry.

It is anticipated that the major use of the Southerly effluent would be for process water. However, wastes from some processing areas could most efficiently be treated separately. Coke plant wastes contain high concentrations of phenols, ammonia, and other organic substances and should be treated separately. Likewise, plans are currently being made to discharge wastes from blast furnace gas washing systems which contain phenols,

cyanide, and ammonia to the City of Cleveland municipal sewer system. Wastes from cold rolling mills which contain oil emulsions would also be treated separately by the steel industry.

If water for use in hot rolling mills (exclusive of one steel mill which has already installed extensive water and wastewater treatment facilities), steel-making furnaces, and pickle rinses were obtained from the Southerly effluent, the average demand would be approximately 50 mgd. However, the terminal treatment facility should be designed to provide tertiary treatment for the entire Southerly wastestream regardless of whether or not it is used in the steel industries.

The estimated cost of this project with provisions for treatment to meet federal water quality goals is summarized in Table XV. Removal of nitrogen and chlorination was assumed to be in treatment provided at the Southerly plant. Equalization facilities at the Southerly plant were included in the cost estimate in order to balance diurnal fluctuations of the municipal waste flow. Provisions were made for a 50 mil gal basin; however, this would have to be evaluated further with respect to land availability in the area of the Southerly plant. The total estimated construction cost of the project is $40,800,000 including allowances for pipeline transport of water included in the Battelle report. Operation, maintenance, and amortization of capital expenditures totaled $0.351/1000 gal.

For treatment to levels required for compliance with state effluent standards, costs would be similar to those listed in Table XV

TABLE XV

ESTIMATED COST FOR COMBINED TREATMENT SYSTEM TO MEET FEDERAL WATER QUALITY GOALS[a]

	Capital Cost ($)	Operating Cost ($/1000 gal)
Pipeline Transport[b]	7,100,000	0.004
Equalization at Southerly	1,000,000	0.001
Treatment at Terminal Treatment Facility		
Chemical Precipitation	6,800,000	0.120
Filtration	4,000,000	0.018
Sludge Handling	800,000	0.033
Aeration	500,000	0.013
Activated Carbon	14,900,000	0.038
Control Structure	100,000	
Contingencies, Engineering and Administration of Contract, and Miscellaneous Costs.	12,700,000	
Total Capital Cost	40,800,000	
Amortization[c]		0.124
Total Treatment Cost		0.351

[a] All costs updated to January 1972 levels.

[b] Cost taken from Butrico, F. A. et al, "Summary Report on Recommended Projects for Pollution Abatement on the Lower Cuyahoga River," for the Ohio Water Development Authority, Battelle Memorial Institute, Columbus, Ohio (1968).

[c] Amortized cost calculated based on useful process lives given in Table A-4. Useful life for pipeline transport system assumed to be 50 yr.

except that carbon adsorption would not be required.

UTILIZATION OF SPENT PICKLE LIQUOR FOR PHOSPHORUS REMOVAL

Two major water quality problems of the Cuyahoga Basin and Lake Erie are excessive nutrients and spent pickle liquors from steel production. With the implementation of agreements made in the International Joint Council, phosphorus removal will be required extensively in the Three Rivers Watershed area. At the present time most spent pickle liquor from steel mills is hauled away for disposal by neutralization and lagooning.

Proposed System

In order to efficiently dispose of spent pickle liquors and phosphorus, Mr. George B. Garrett of the Ohio Department of Health has proposed that the pickle liquor be used in municipal wastewater treatment plants as a coagulant for phosphorus removal. A similar method of phosphorus removal has recently been investigated by the City of Milwaukee Sewerage Commission [31] and by the Rand Development Corporation [32]. In Milwaukee waste sulfuric acid pickle liquor was added to the aeration basin of a 115 mgd activated sludge plant. Total phosphorus concentrations were reduced from 8.2 mg/l to 0.70 mg/l as phosphorus during the test period. Soluble phosphorus concentrations of the influent sewage averaged 3.1 mg/l during the course of the study. The high fraction of insoluble phosphorus was probably due to the high concentration of iron in the

waste which averaged 7.2 mg/l over the one-year test period. The average iron dosage added to the wastewater was 9.4 mg/l as Fe which was equivalent to a Fe/soluble P weight ratio of 3.0. However, no attempt was made to determine an optimum dosage.

In the Rand study at Mentor, Ohio, greater than 80 percent phosphorus removal was accomplished using spent pickle liquor. Iron dosages ranging from 2.7 to 3.1 g Fe/g P were used and supplemented with 1.6 to 1.7 g $Ca(OH)_2$/g Fe. It was estimated that phosphorus removal exceeding 90 percent could be attained using filtration. It was also suggested that filtration might be necessary to reduce effluent iron concentrations which averaged 10 mg/l during the course of the 23-mo study.

At the present time, there is some question concerning the relative desirability of ferrous and ferric salts for phosphorus removal. Although ferric salts are most often employed for this purpose, several investigators have studied the use of ferrous iron [33, 34]. Singer [35] recently reported the solubility product of $Fe_3(PO_4)_2$ to be 1.3×10^{-30} which compares to values of 1×10^{-22} for $FePO_4$, 1×10^{-29} for $AlPO_4$, and 6.3×10^{-19} for $Ca_3(PO_4)_2$ [36]. Since the iron in pickle liquor is present as a ferrous salt, $FeCl_2$ would be the most convenient coagulant in this case. However, if $FeCl_3$ is desired, chlorination of the pickle liquor would be accomplished at these processing sites. Chlorine is manufactured in several plants in the Study Area and would be readily available for such use.

Preliminary calculations by Garrett [37] showed that approximately 5,000,000 lb $FeCl_2$/mo is currently produced in the Cleveland-Youngstown area steel mills which is equivalent to 26,000,000 lb Fe/yr. Based on a Fe:P weight ratio of 5:1, this quantity of iron could be used to precipitate 5,200,000 lb P/yr. This is approximately 55 percent of the estimated 9,160,000 lb/yr of phosphorus discharged from domestic and commercial sources in the Three Rivers Watershed area. While the quantity of available pickle liquor appears to be insufficient to remove all the phosphorus generated in the Study Area, the required Fe:P ratio might be less than the 5:1 value used for this analysis. The required iron dosage, which should be determined individually for each treatment plant, would be affected by the quantity of iron in the influent waste available to precipitate phosphorus, the quantity of insoluble phosphorus present in the waste, and the quantity of phosphorus removed by snythesis in biological treatment processes.

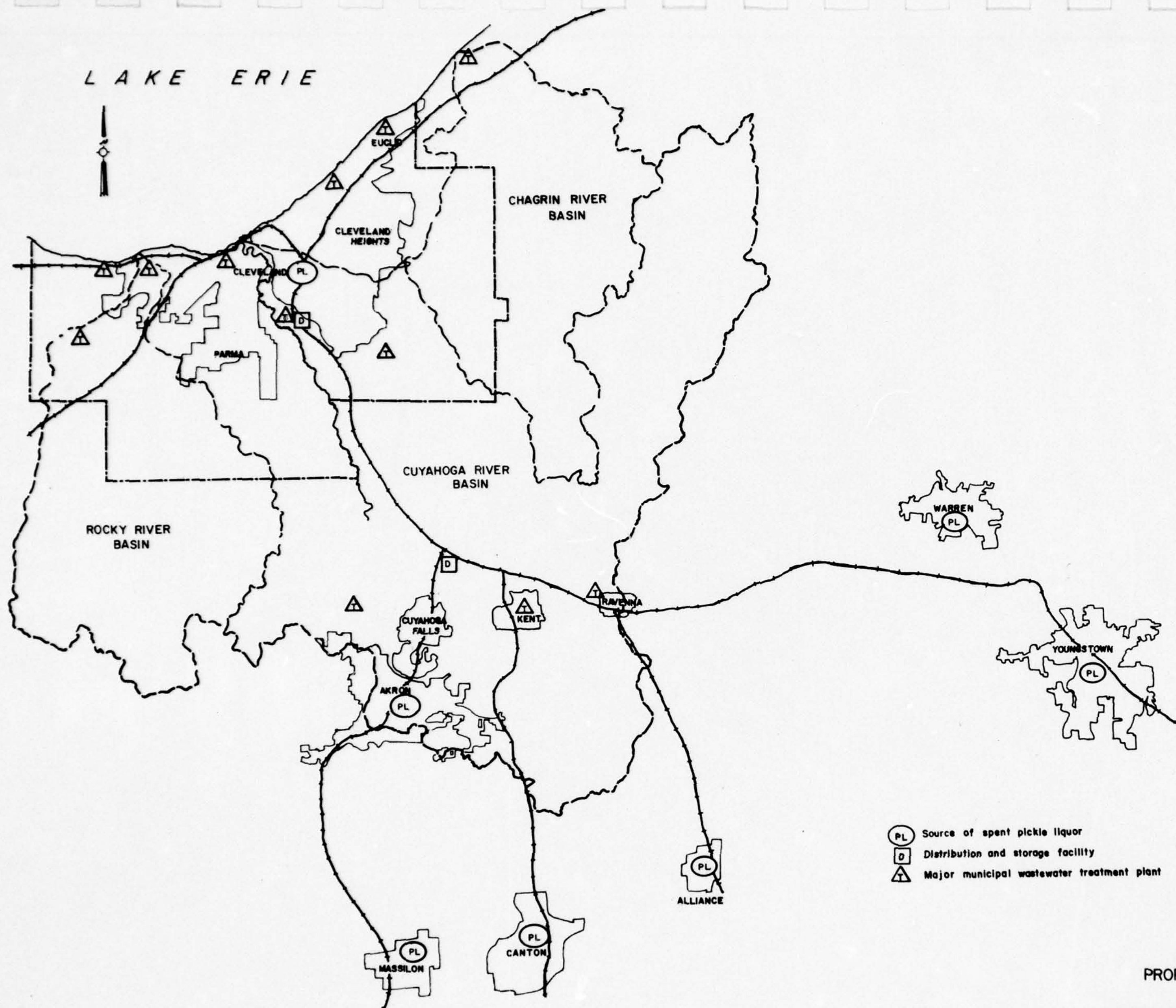
Because of the variables associated with determining required iron doses, the adequacy of the available pickle liquor for removing phosphorus in the entire Study Area cannot be evaluated without further study. However, if the iron available in pickle liquor were inadequate for the entire area, some plants could obtain ferric chloride from commercial sources. As long as the cost of using pickle liquor is less than the cost of purchasing other coagulants, the system would be of

value regardless of the quantity available.

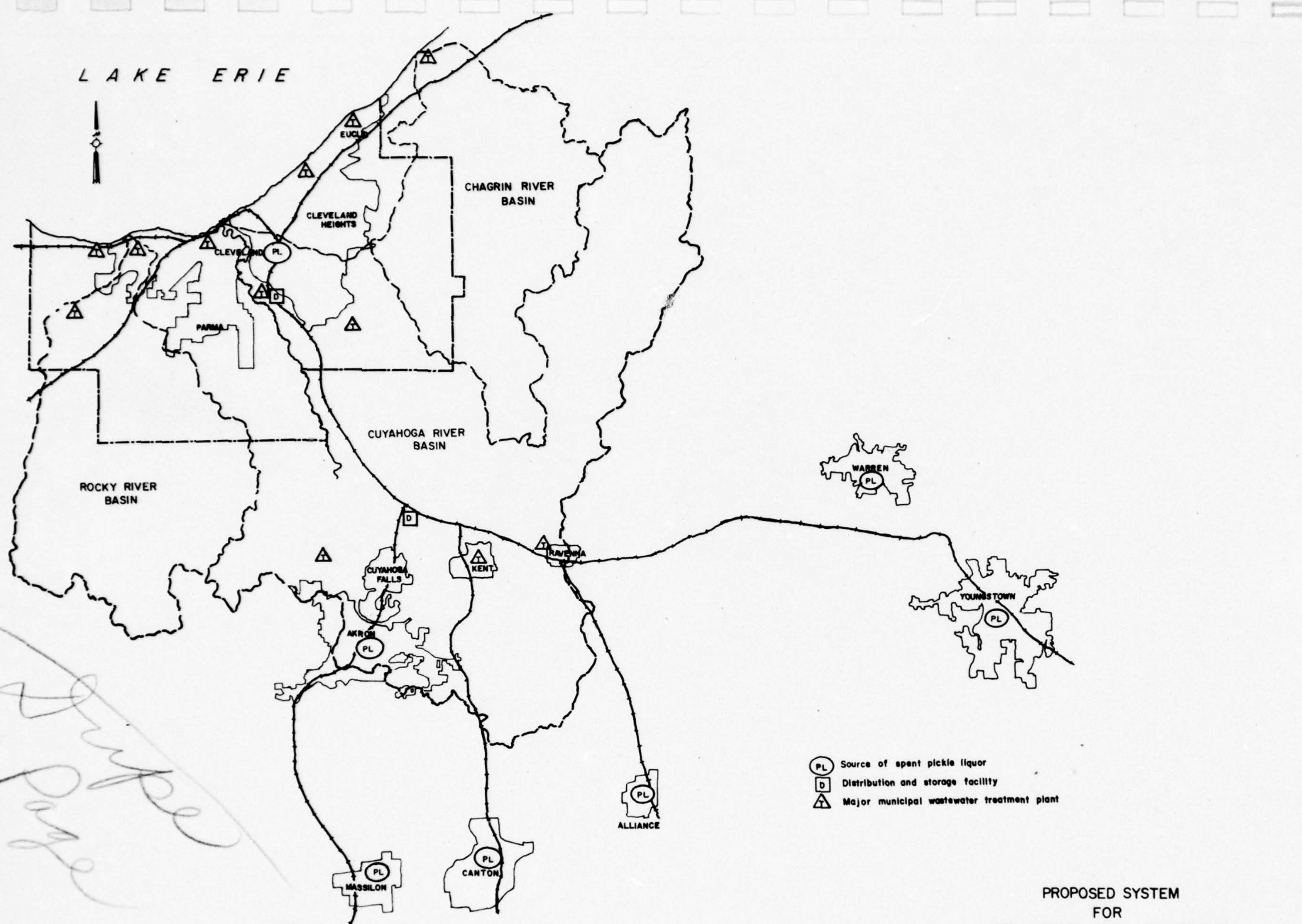
Because pickle liquor also contains 3 - 6 percent free acid, partial neutralization might be required before use as a coagulant. Slag from steel mills or fly ash could possibly be used for this purpose. In this manner, the residual acidity of pickling solutions could be adjusted in order to obtain an optimum pH for $Fe_3(PO_4)_2$ precipitation. However, neutralization would increase the quantity of dissolved solids added to the wastewater. For the quantity of iron usually required for phosphorus removal, the pickle liquor addition should not significantly lower the pH of wastewaters having moderate concentrations of alkalinity. In the City of Milwaukee study [31], no neutralization was required using pickle liquor having an average free acid content of 6 percent. The alkalinity of the raw wastewater averaged 224 mg/l as $CaCO_3$ over the period of the study.

Collection and Distribution Facilities

The proposed system for collection and distribution of pickle liquor is shown in Figure 27. Pickle liquor produced in the Cleveland steel mills would be collected and transported by truck to a collection and distribution site. This site is proposed for the Cleveland Southerly treatment plant because of its proximity to the Cleveland steel mills and because less transfer of the liquor would be required in view of the quantity required for use at the Southerly plant. Another collection point is proposed for the Akron area for collection



PROPOSED SYSTEM
FOR
COLLECTION AND DISTRIBUTION
OF
SPENT PICKLE LIQUOR
FIG. 27



PROPOSED SYSTEM
FOR
COLLECTION AND DISTRIBUTION
OF
SPENT PICKLE LIQUOR
FIG. 27

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and distribution of pickle liquor generated in Canton, Massilon, Alliance, and Youngstown areas.

It is estimated that a 1.5 mil gal storage facility at each distribution site would provide approximately 30 days storage for equalization and reserves necessary to provide an adequate supply of pickle liquor during possible strikes in the steel industry. For the proposed locations, the facility in Cleveland would serve the City of Cleveland treatment plants and others located near the lake shore. The facility in the Akron area would serve Akron and other plants in Summit, Portage, and Medina counties. In order to maintain a balance between the supply and demand for each facility, treatment plants located in the areas between each facility would receive pickle liquor from either distribution point.

Transport of the pickle liquor from the various industries to the distribution center could be by truck or rail. For railway transport of pickle liquor from the Canton and Youngstown areas to the Akron facility, freight charges would be approximately $0.045/gal including a nominal allowance for the construction of spur lines. The cost of installing switching equipment from the main rail line is refundable to the user based on a fixed rate per railroad car used over a five- or ten-year period. For the projected use of the rail line at each facility, this amount would be completely refunded in the first five years of operation.

Trucking costs were estimated based on a cost of \$0.65/mi which is the rate currently being charged for the transport of spent pickle liquor in the Cleveland-Akron area. For tank trucks having a capacity of 5,000 gal or more, the cost would be approximately \$0.01/gal(\$0.014/lb Fe) from the Canton or Youngstown areas to the Akron distribution point. From this analysis, transport by tank truck appears to be significantly less costly than transport by rail.

Cost Analysis

To estimate the cost of pickle liquor used for phosphorus removal, the following factors were considered: 1) transport of the pickle liquor from the industrial site to the distribution facility and subsequently to the treatment plant, 2) capital costs required for the distribution facility, and 3) operation and maintenance of the distribution site. Capital costs in the estimate include a steel storage tank with a structural steel roof, foundation, and rubber lining; pumps and piping to handle loading and unloading of two trucks simultaneously; docking and control facilities; and associated yardwork. Pumps were assumed to be constructed of stainless steel and have a capacity of 300 gpm. This would allow loading of an 8,000 gal truck in approximately 30 min. Piping costs were estimated using PVC pipe and fittings. Operational and maintenance labor was estimated based on two full time employees per facility at a rate of \$5/hr including overhead and benefits. Labor costs for transport of pickle liquor

was included in transportation charges. Costs of storage tanks were based upon bid prices for recently installed tanks of similar tanks obtained from steel fabricating firms.

A summary of the estimated cost of this project are given in Table XVI. Original capital, replacement, and operation and maintenance were calculated as a present worth value, then placed on an equivalent annual cost basis using 7 percent interest. The estimated unit cost of $0.035/lb Fe includes all costs for the distribution site and transport to individual treatment sites. Average transport costs of $0.014/lb Fe ($0.01/gal) were used as an estimate of transport charges to the distribution site and to the individual treatment plants. For plants located close to the distribution sites, the total cost would be correspondingly lower. Not included in this estimate is the reduction of pickle liquor disposal costs being incurred by industry.

The estimated cost of iron using spent pickle liquor is $0.035/lb Fe. This compares to the January 1972 price for ferric chloride in the Cleveland area of $0.343/lb Fe. Although this analysis is only a preliminary investigation, the results indicate that the use of spent pickle liquor for phosphorus removal is feasible.

Additional factors which should be investigated before the implementation of this project include the concentrations of suspended solids and heavy metals present in the spent pickle liquor. While some suspended solids are present in the liquor, it is not felt that the concentration is great enough to cause problems in the distribution facilities. If the level were high enough to be of concern, provisions

TABLE XVI

ESTIMATED COST FOR PICKLE LIQUOR COLLECTION AND DISTRIBUTION FACILITY

Capital Cost[a]	
Storage tank including foundation, rubber lining, and installation	$ 330,000
Pumps and piping	15,000
Yardwork and control facilities	45,000
Contingencies, land, engineering, and administration of contract	176,000
	$ 566,000
Operation and Maintenance Cost[a]	
Labor	$ 21,000/yr
Materials and electricity	20,000/yr
Painting of storage tank - 5 yr intervals	8,000
Present Worth of Project (7% interest)	
Original capital cost	$ 566,000
Replacement costs	54,000
Labor	290,000
Materials and electricity	276,000
Painting	11,000
Total	$1,197,000
Equivalent Annual Cost	$ 86,600/yr
Unit Cost[b]	$ 0.035/lb Fe

[a] Costs calculated for one distribution site; costs of both sites are assumed to be the same.

[b] Includes cost for amortization and operation of distribution facility, transport from industry to the distribution site, and transportation from the distribution site to individual treatment plants. Distribution site costs calculated for handling of 13,000,000 lb Fe/yr for each distribution site.

for sedimentation would have to be added to the design of each distribution facility. Heavy metals, if present in significant quantities, would present a more difficult problem.

Collection and Disposal of Oil, Brine, and Sludge

The disposal of oils, brines, and sludges will be a major cost of water pollution control with the implementation of water quality criteria used in this study. Exclusive of waste solids and oil which would be recovered in the steel industry, approximately 50 truck loads of sludge (based on the use of 10 tn trucks) would be generated from industrial wastewater treatment facilities each day. In addition, for treatment to Level II standards, approximately 20 truck loads per day of salts would be produced if brines produced in demineralization processes are evaporated. If brine solutions are collected for deep well injection, approximately 440 loads/day using 5,000 gal trucks would be required.

While the formation of an independent agency might be considered to collect industrial sludges if deep well injection of brines is used, contracting with private firms would probably be most economical in other situations. Several firms presently exist in the Study Area which could adequately handle the volumes of waste material generated.

With respect to waste oils, two waste oil refineries located near the Study Area should be able to provide adequate facilities for refining of waste oils where possible and disposal of unreclaimable

waste oils. Perhaps the most valuable role for a regional wastewater management authority would be to encourage development of tax advantages for the sale of reclaimed by-products.

ATTACHMENT A

UNIT PROCESS COSTS

This attachment contains unit cost functions used for the estimation of industrial treastment costs. All costs have been corrected to Jan. 1972 price levels (WQO-STP Index = 176, EN-R Skilled Labor Index = 1556). The items included in each cost function are discussed and the source of each model given.

UNIT PROCESS COSTS

GENERAL COST CONSIDERATIONS

The waste treatment processes presently used in industrial applications vary from none at all through chemical and biological treatment to full disposal to the sea, incineration of the whole stream or deep well disposal into an acceptable geophysical formation. The diagramatic sketch in Figure A-1 lists the possible ways of handling the waste and their approximate sequence. This discussion will be limited to the capital, operating and maintenance costs of the individual wastewater.

Through the use of various cost indexes the unit processes were converted to January, 1972 values. For this study, the indexes used were the Engineering News-Record (EN-R)Skilled Labor Cost Index for operation and maintenance costs and the Water Quality Office-Sewage Treatment Plant Index (WQO-STP) for capital costs for the last 10 years. A summary of the WQO-STP index over the past 15 years is presented in Table A-I. When older models were presented on the basis of an index other than the WQO-STP Index, they were converted using the following values:

EN-R Construction Cost Index for January, 1972	= 1,665.6
EN-R Building Cost Index for January, 1972	= 1,000.95
EN-R Skilled Labor Cost Index for January, 1972	= 1,556.0

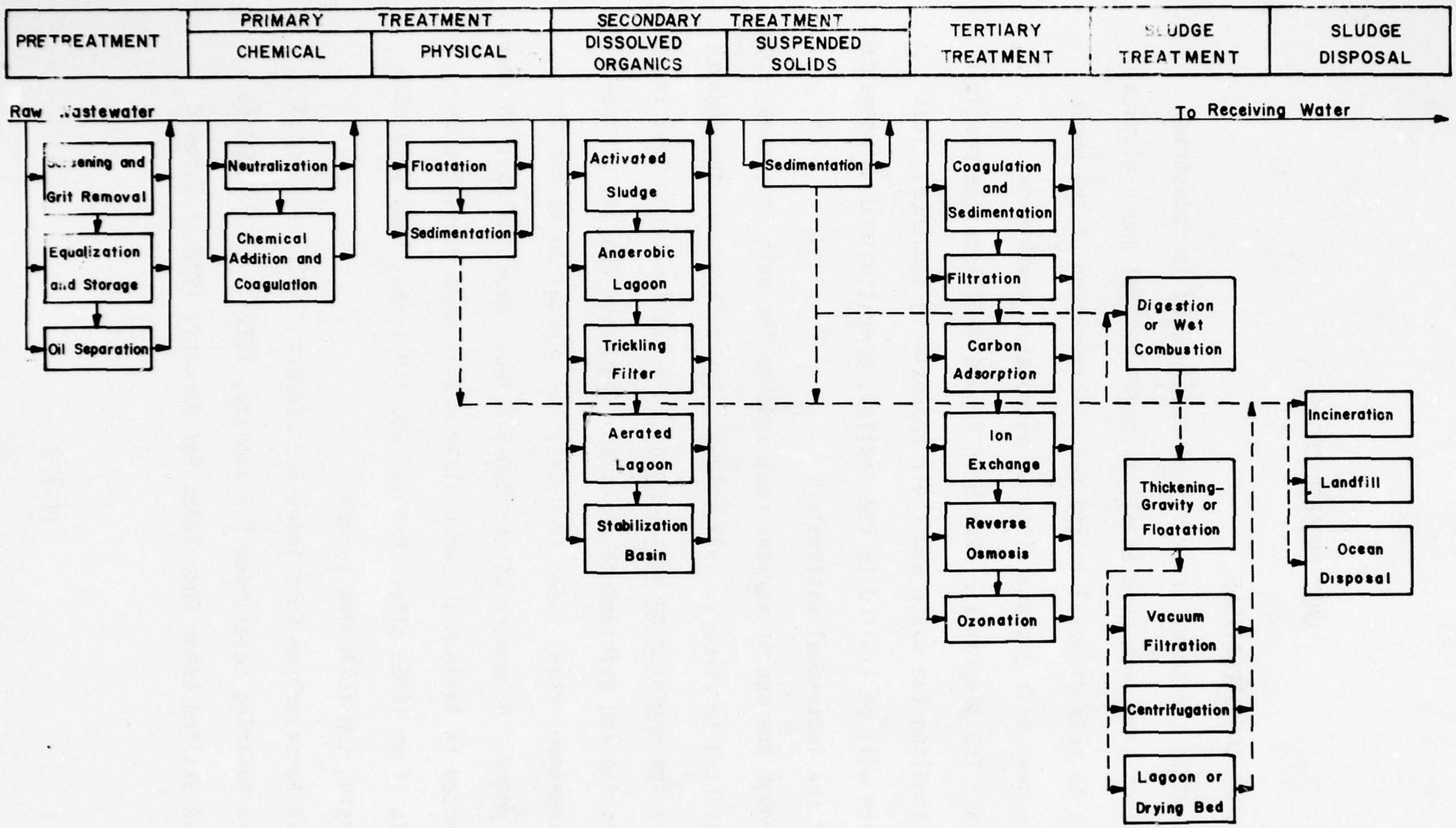

FIG. A-1. WASTEWATER TREATMENT SEQUENCE: PROCESSES SUBSTITUTION DIAGRAM

Reference Eckenfelder, W.W., Jr. Water Quality Engineering For Practicing Engineers, Barnes & Noble, New York, 1970

TABLE A-I

SEWAGE TREATMENT PLANT CONTRUCTION COST INDEX (WQO-STP)[a]

Year	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL INDEX
1957	-	-	-	-	-	-	-	-	-	-	-	-	98.04
1958	-	-	-	-	-	-	-	-	-	-	-	-	101.50
1959	-	-	-	-	-	-	-	-	-	-	-	-	103.65
1960	-	-	-	-	-	-	-	-	-	-	-	-	104.96
1961	-	-	-	-	-	-	-	-	-	-	-	-	105.83
1962	-	-	-	-	-	-	-	-	107.19	107.20	107.03	106.84	106.99
1963	106.80	107.05	107.08	107.11	107.22	107.78	108.07	108.52	108.58	109.54	109.51	109.60	108.52
1964	109.64	109.45	109.53	109.57	109.70	109.99	110.24	110.54	110.63	110.69	110.73	110.68	110.11
1965	110.82	111.04	111.07	111.12	111.15	111.83	112.31	112.57	112.70	112.82	112.87	113.09	111.95
1966	114.05	114.60	114.77	115.08	115.34	116.05	116.82	116.92	117.11	117.51	117.46	117.48	116.10
1967	117.76	118.08	118.11	118.22	118.34	119.11	119.63	120.28	120.59	120.89	120.91	121.01	119.41
1968	121.10	121.20	121.21	121.55	121.71	122.49	123.39	123.69	124.53	126.80	127.24	127.71	123.55
1969	128.68	129.50	129.84	130.03	130.03	131.11	132.44	135.34	135.46	135.85	136.61	136.86	132.65
1970	137.63	137.87	138.15	138.49	141.18	143.03	146.25	146.70	147.45	148.07	149.28	149.63	143.64
1971	150.60	150.89	153.34	155.41	157.29	158.62	160.58	165.07	166.30	166.25	166.44	167.19	159.83
1972[b]	176.03	-	-	-	-	-	-	-	-	-	-	-	-

[a] SOURCE: Sewer and Sewage Treatment Plant Construction Cost Index, Environmental Protection Agency, Washington, D.C.

[b] Average for Boston, Cleveland, Detroit, Chicago, and San Francisco.

It is very useful for this and other studies to convert the costs to the prevalent costs in the locale of the proposed construction. Table A-II presents the WQO-STP Index as well as the WQO-Sewer Index for January, 1972, levels in 20 selected cities.

Many process units are constructed in duplicate to serve on a standby basis. A list of the average amount of standby units that are found for treatment processes is presented in Table A-III. This does not take into account the fact that for larger plants, the percentage standby units will be smaller than for smaller plants.

UNIT PROCESS COSTS

After converting the cost of the unit processes to January 1972 levels, the figures were plotted against the most significant design parameter. The curves obtained were then used to estimate construction costs and operation and maintenance costs for the chosen combination of waste treatment steps. Table A-IV is a summary of the unit processes covered in this discussion. Included in this table are the basis for the estimation of capital costs, the approximate life expectancy of the process, the excess capacity factor applied to the process design, and the figure number and source of the model. A short discussion of the unit cost curves and the source of the information is presented below.

Control House

The capital cost relationship for the construction of a control house is presented in Figure A-2. The original relationship was prepared by Smith [38] and includes a laboratory and shop facility.

TABLE A-II

SEWAGE TREATMENT PLANT AND SEWER CONSTRUCTION COST INDEX
FOR TWENTY SELECTED CITIES

For January, 1972 (1957-1959 = 100)

Cities	WQO-STP Values	% Change Jan. 1971	WQO-S Jan. 1971	% Change Jan. 1971
Atlanta	152.32	+ 10.7	154.37	+ 11.5
Baltimore	158.76	+ 13.8	166.05	+ 14.1
Birmingham	141.03	+ 13.9	143.93	+ 14.7
Boston	173.83	+ 14.7	193.11	+ 23.2
Chicago	173.71	+ 12.0	193.88	+ 25.0
Cincinnati	168.86	+ 10.3	181.28	+ 9.9
Cleveland	175.09	+ 11.1	192.82	+ 14.9
Dallas	142.30	+ 8.3	143.68	+ 4.8
Denver	151.32	+ 11.4	153.42	+ 16.6
Detroit	180.73	+ 10.6	200.77	+ 16.6
Kansas City	177.10	+ 11.4	190.49	+ 15.2
Los Angeles	175.51	+ 14.6	183.34	+ 16.1
Minneapolis	172.86	+ 10.7	189.79	+ 14.7
New Orleans	152.36	+ 9.0	154.50	+ 8.9
New York	196.63	+ 12.0	218.60	+ 19.3
Philadelphia	173.81	+ 15.5	197.87	+ 25.7
Pittsburgh	173.57	+ 10.7	178.56	+ 8.2
St. Louis	170.10	+ 10.3	183.73	+ 7.9
San Francisco	176.79	+ 8.5	189.42	+ 6.7
Seattle	167.88	+ 8.4	181.66	+ 7.6
Average Values				

[a] Source: Sewer and Sewage Treatment Plant Construction Index, Environmental Protection Agency, Washington, D.C.

TABLE A-III

EXCESS CAPACITY FACTORS FOR PROCESS UNITS

Process	Factor
Control house	1.0
Equalization	1.0
Oil separation	1.0
Neutralization	1.0
Primary clarification	2.0
Activated sludge	1.2
Aeration	1.5
Sludge return	2.0
Final clarification	2.0
Chemical coagulation	1.5
Ion exchange	1.2
Reverse osmosis	1.2
Filtration	1.0
Dissolved air flotation	1.5
Vacuum filtration	1.0

TABLE A-IV

SUMMARY OF TREATMENT COST RELATIONSHIPS

Process	Remarks	Capital Cost Basis	Approx. Life (yr)	Excess Capcy. Factor	Model Location (Fig.)	Model Reference
Control House	Lab and shop	Flow	50	1.0	2	[38]
Equalization	-	Volume	50	1.0	3	[43]
Oil Separation	-	Flow	25	1.0	4	[39]
Neutralization	Equal, oil rem, oval, sludge dewat.	Flow, acid-alk.	25	1.0	5,6	[1]
Primary Clarification	750 gpd/sq ft	Area	30	2.0	7,8	[43], [41]
Activated Sludge	Concrete, mech aerators	Volume Area	50	1.2	9,10,11	[51], [41]
Secondary Clarification	650 gpd/sq ft	Area	30	2.0	12,13	[51], [41]
Rapid Mix Flocculation	Added equip.	Flow	30	2.0	14	[54]
Lime Feed	Added equip.	Flow	30	1.0	15	[54]
Complete Lime Treatment	After secondary treatment	Flow	30	1.5	16	[54]
Chemical Addition	Cost of chemicals, labor, etc.	-	-	-	17,18	[54]
Ion Exchange		Flow, T.D.S.	20	1.2	19,20,21	[1]
Reverse Osmosis	After activated carbon or filtration	Flow	20	1.2	22,23	[47]
Deep Well Disposal	900 psi injection pressure	Flow	20	1.0	24,25	
Evaporation		Flow	20	1.0	26,27	
Filtration	Sand or graded media 4 gpm/sq ft	Flow	40	1.0	28,29	[45]
Vacuum Filtration	Filter, pumps and piping	Filter Area	25	1.0	31,32,33	[50], [41]
Cyanide Destruction, Chrome Reduction	-	Flow	30	1.0	34	
Cooling	Wet, mech. draft, crossflow tower	Flow	20	1.0	35,36	
Dissolved Air Flotation		Flow	30	1.5	30	[52]

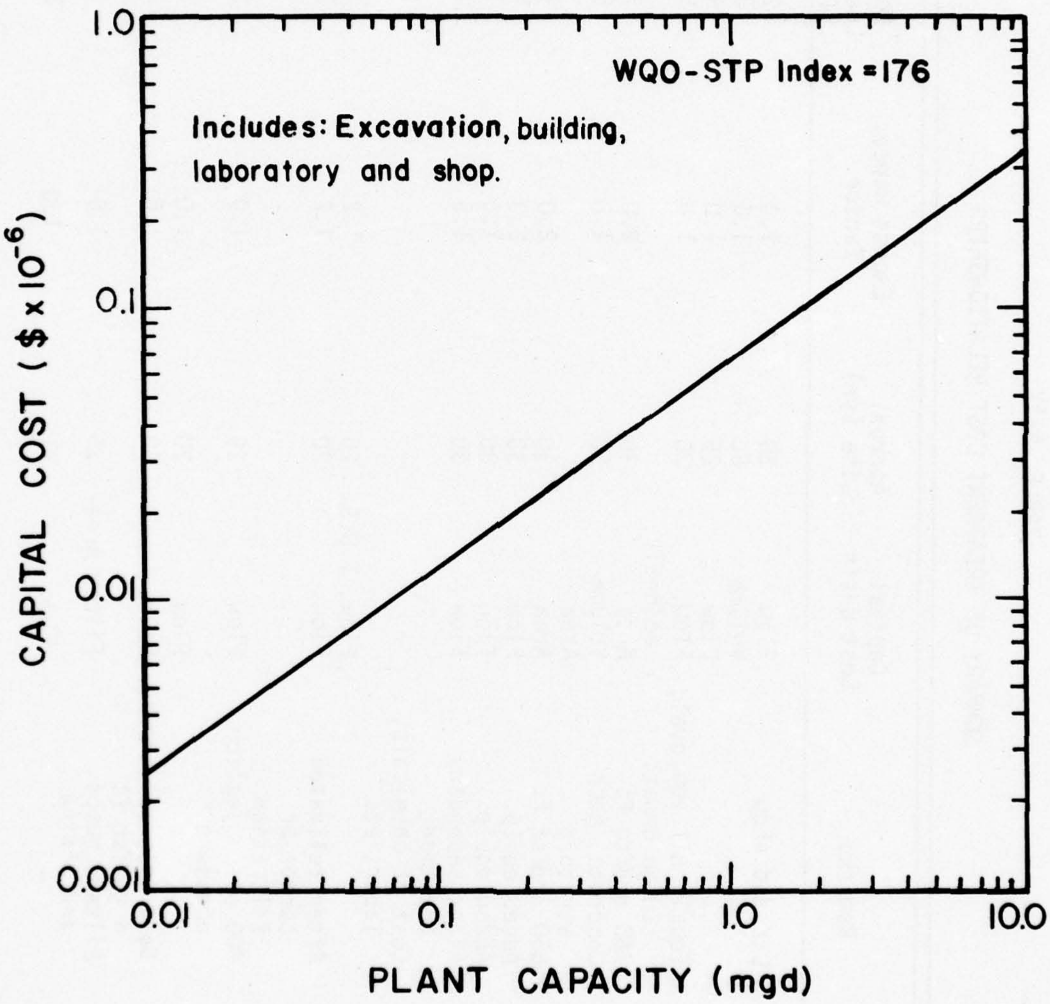

FIG. A-2. CAPITAL COST OF CONTROL HOUSE

The cost of the control house is plotted against the plant capacity in mgd. For industries which would not require complete laboratory and shop facilities in the treatment plant area, adjustments must be made in using this relationship.

Equalization

The determination of the size of the equalization facility is dependent upon the variation within each industrial plant and it is very difficult to generalize. The cost was calculated to include the mixing apparatus and was plotted as a function of the basin volume. The original curve, prepared by Chow [43] and modified by Bernard [39], is presented in Figure A-3.

Oil Separation

The cost of oil separators can be based on volume, surface area or flow. If a constant overflow rate is assumed, the cost may be based on the average flow. The capital cost relationship for oil separation is presented in Figure A-4, prepared originally by Barnard [39].

Neutralization

The cost of neutralization units can be based either on volume of the reaction chamber or on the average daily flow. For this study, it was assumed that the same contact time would be used for all industries and the capital cost would be plotted as a function of the flow. The capital cost relationship is presented in Figure A-5 was obtained from a study of the inorganic chemicals industry [1].

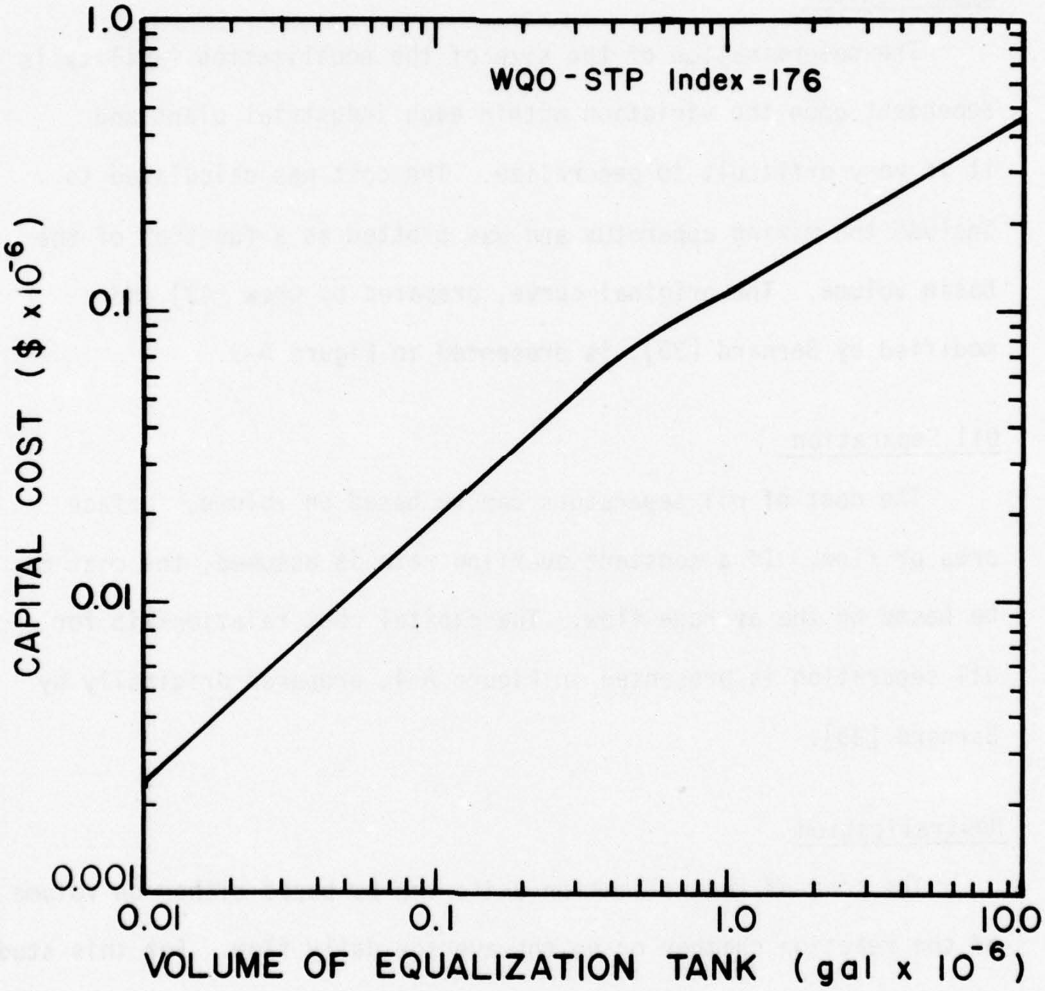

FIG. A-3. CAPITAL COST OF EQUALIZATION

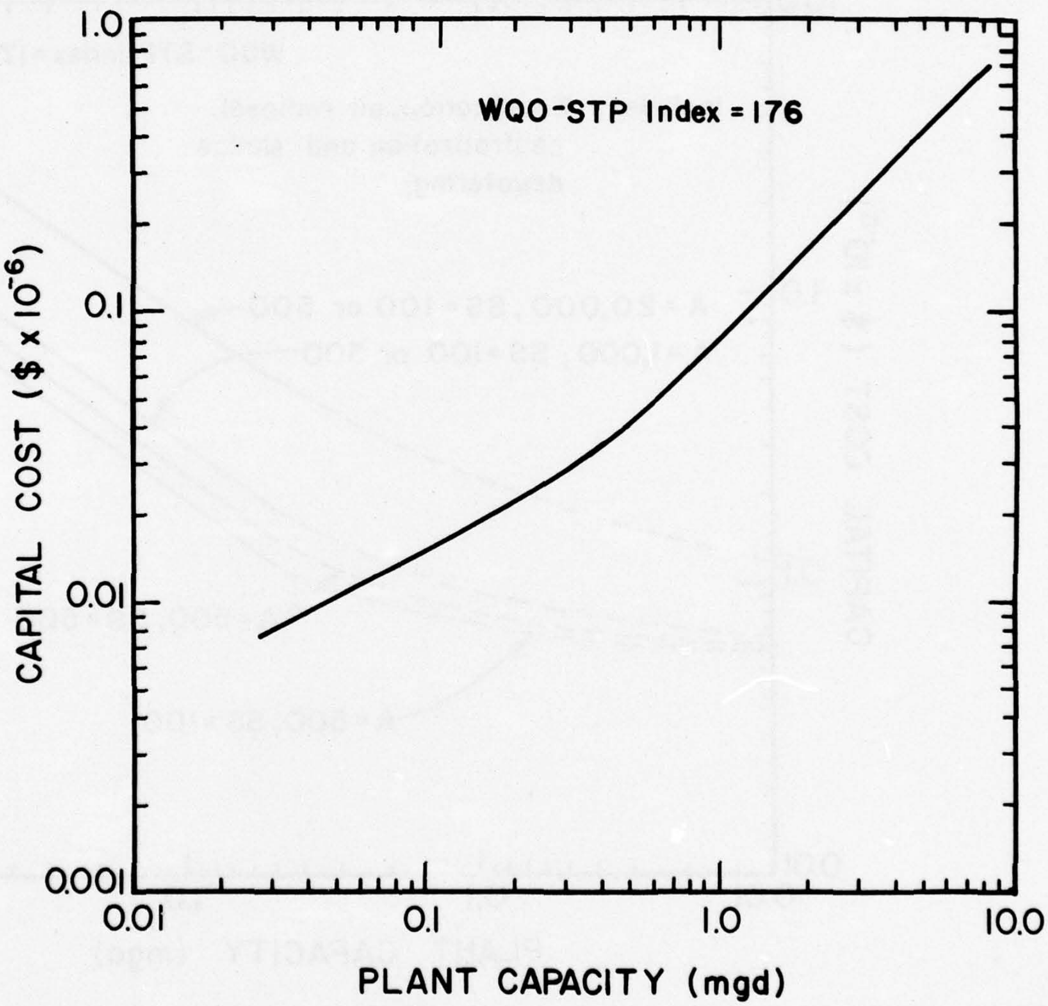

FIG. A-4. CAPITAL COST OF OIL SEPARATION

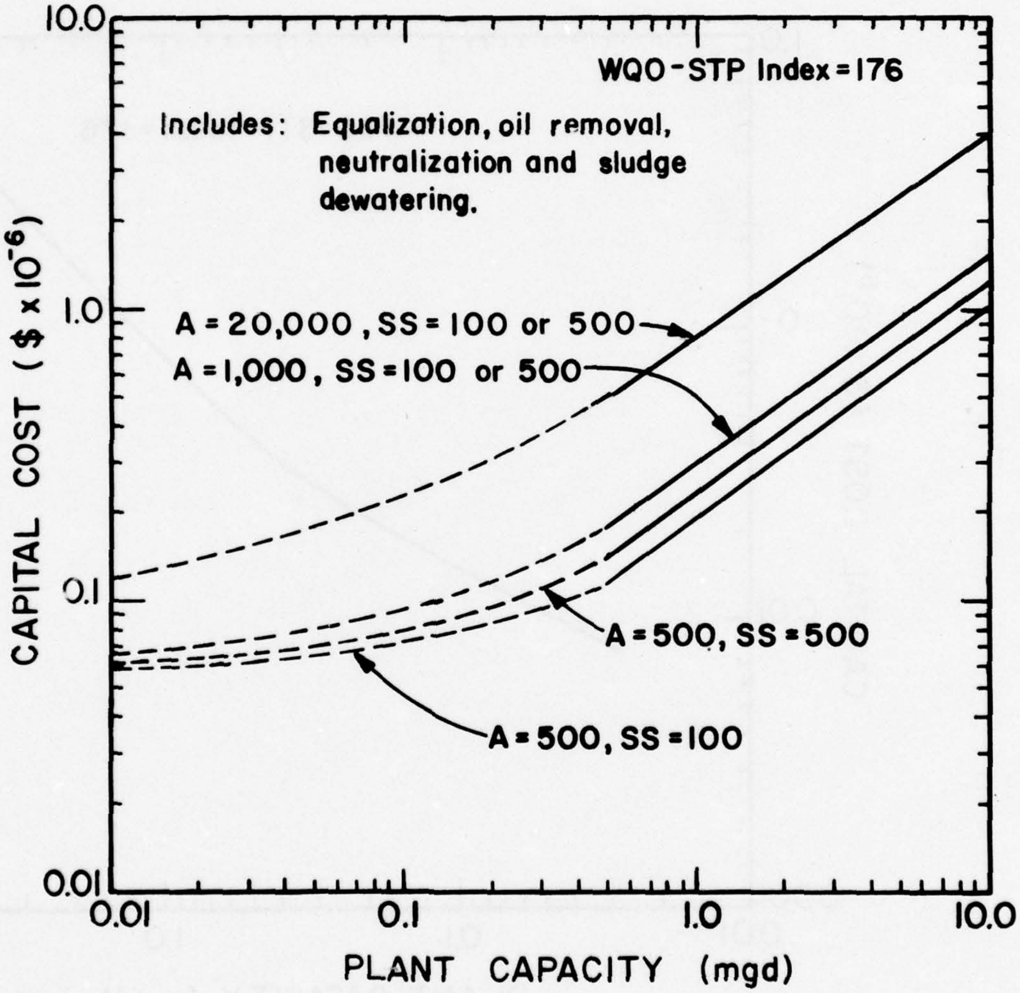

FIG.A-5.CAPITAL COST OF NEUTRALIZATION SYSTEM

The cost model includes equalization, oil removal, neutralization and sludge dewatering. The effects of varying acidity and suspended solids are shown in the relationship. Figure A-6 presents the operation and maintenance cost relationship for a neutralization facility including chemical costs.

Primary Clarification

The capital cost relationship and the operation and maintenance relationship for primary clarification are presented in Figures A-7 and A-8, respectively. The capital cost relationship was obtained from Chow [43] and is based on an overflow rate of 750 gpd/sq ft. Operation and maintenance costs were obtained from Patterson [41] and include labor, materials, and supplies at an overflow rate of 750 gpd/sq ft.

Activated Sludge

The capital cost relationship for activated sludge was based on the volume of the aeration basin and is presented in Figure A-9. The relationship was obtained from Di Gregorio [51] and includes the concrete and mechanical aerator costs. Di Gregorio also presented power costs of aerators for activated sludge which is presented in Figure A-10. The operation and maintenance presented in Figure A-11, for mechanical aeration including labor only was obtained from Patterson [41] and is presented as a function of total applied horsepower.

Secondary Clarification

The capital cost and operation and maintenance cost relationships for secondary clarification are presented in Figures A-12 and

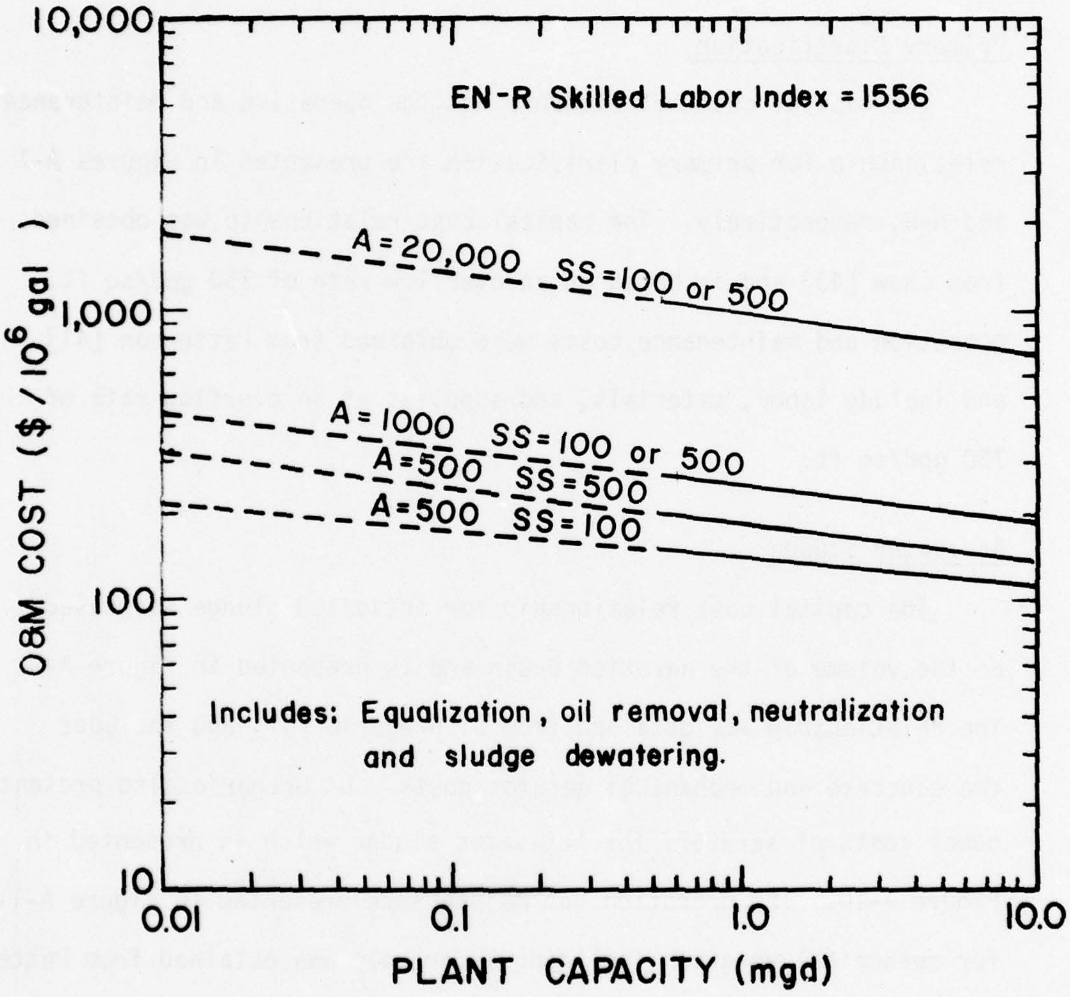

FIG. A-6. OPERATION AND MAINTENANCE COST FOR NEUTRALIZATION SYSTEM

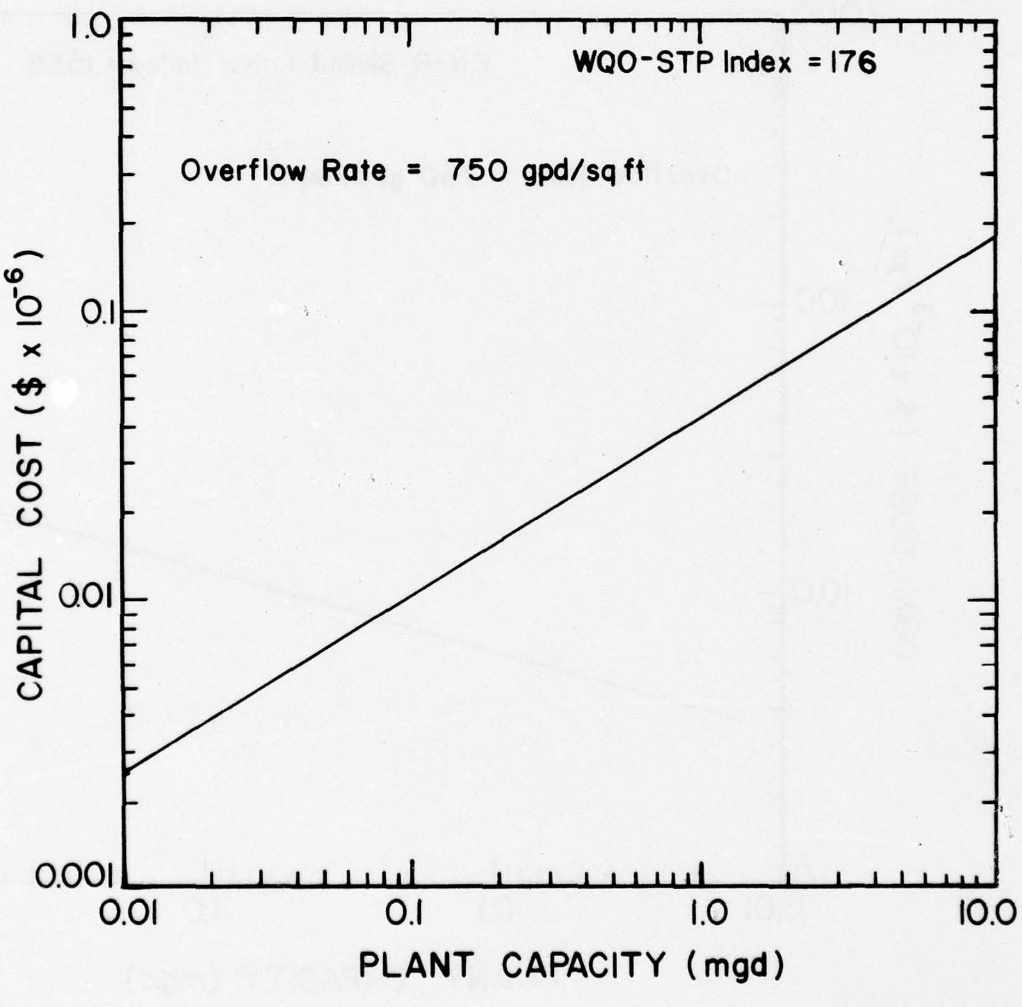

FIG. A-7. CAPITAL COST OF PRIMARY CLARIFICATION

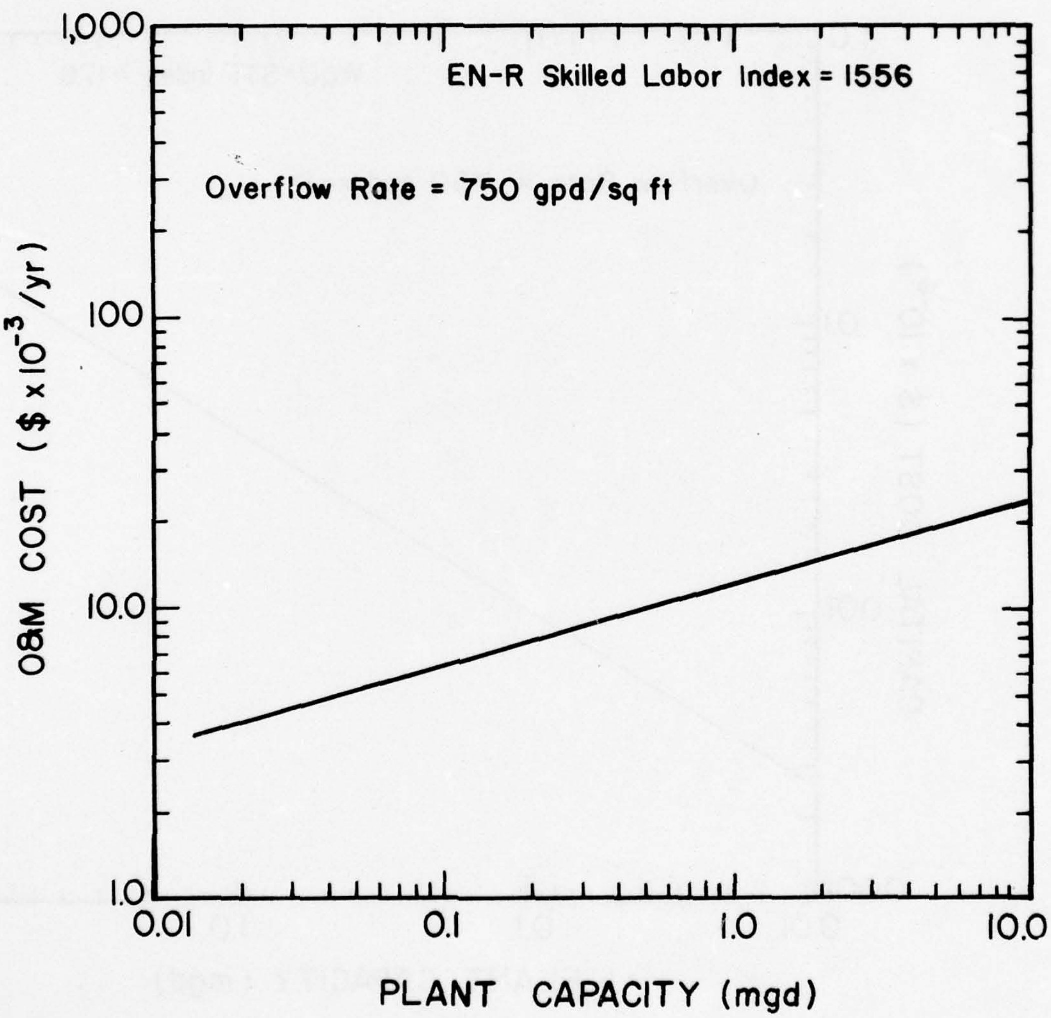

FIG. A-8. OPERATION AND MAINTENANCE COST OF PRIMARY CLARIFICATION

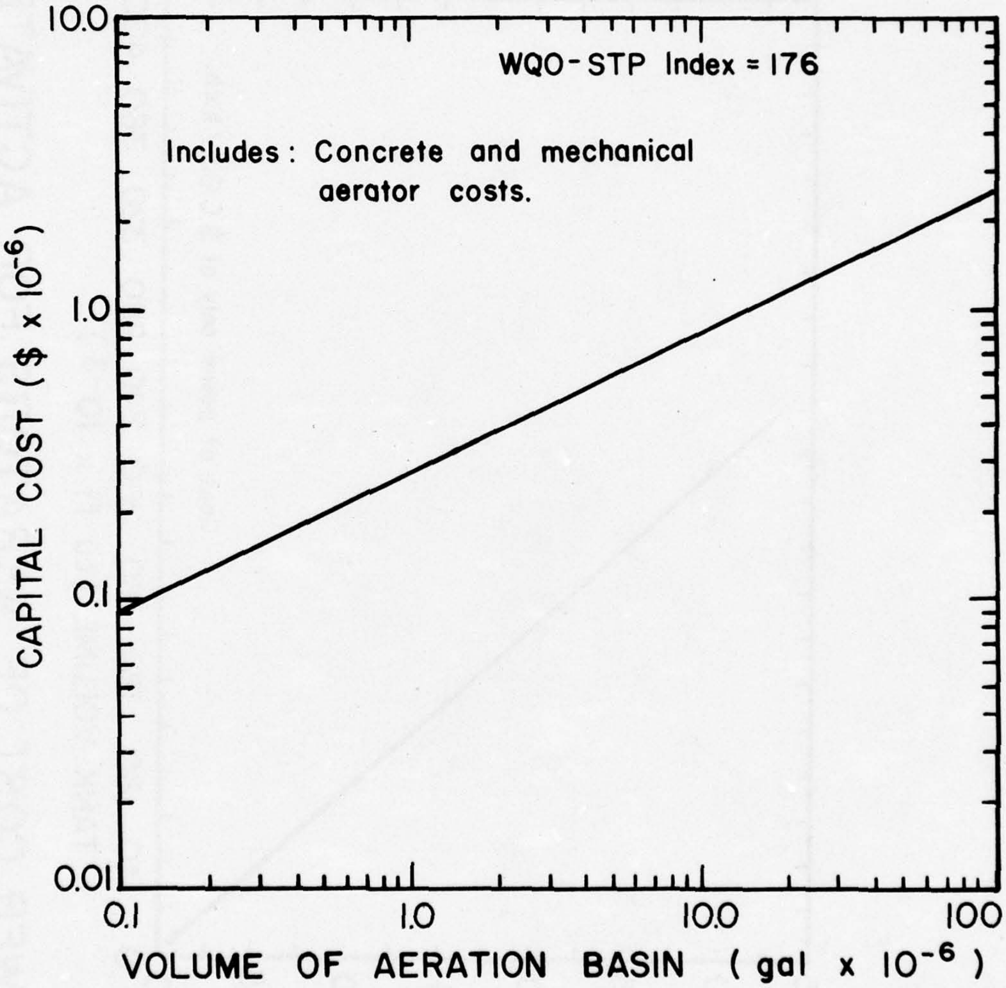

FIG. A-9. CAPITAL COST OF ACTIVATED SLUDGE BASIN

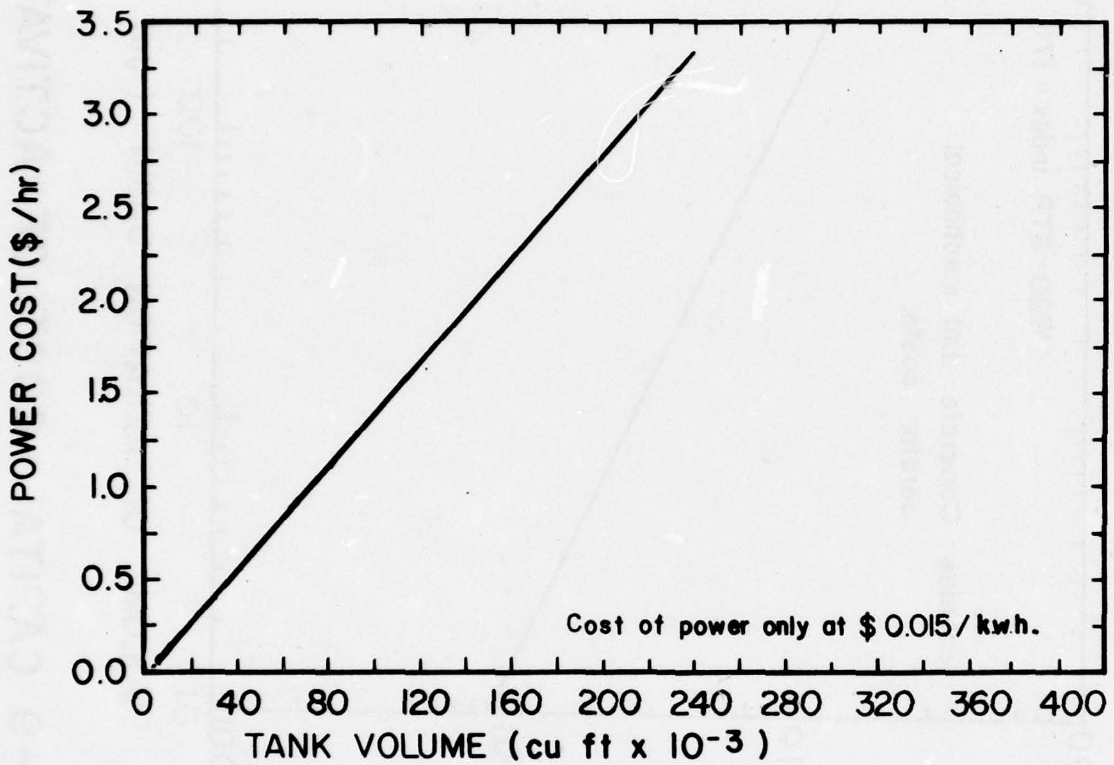

FIG. A-10. POWER COST OF AERATORS FOR ACTIVATED SLUDGE

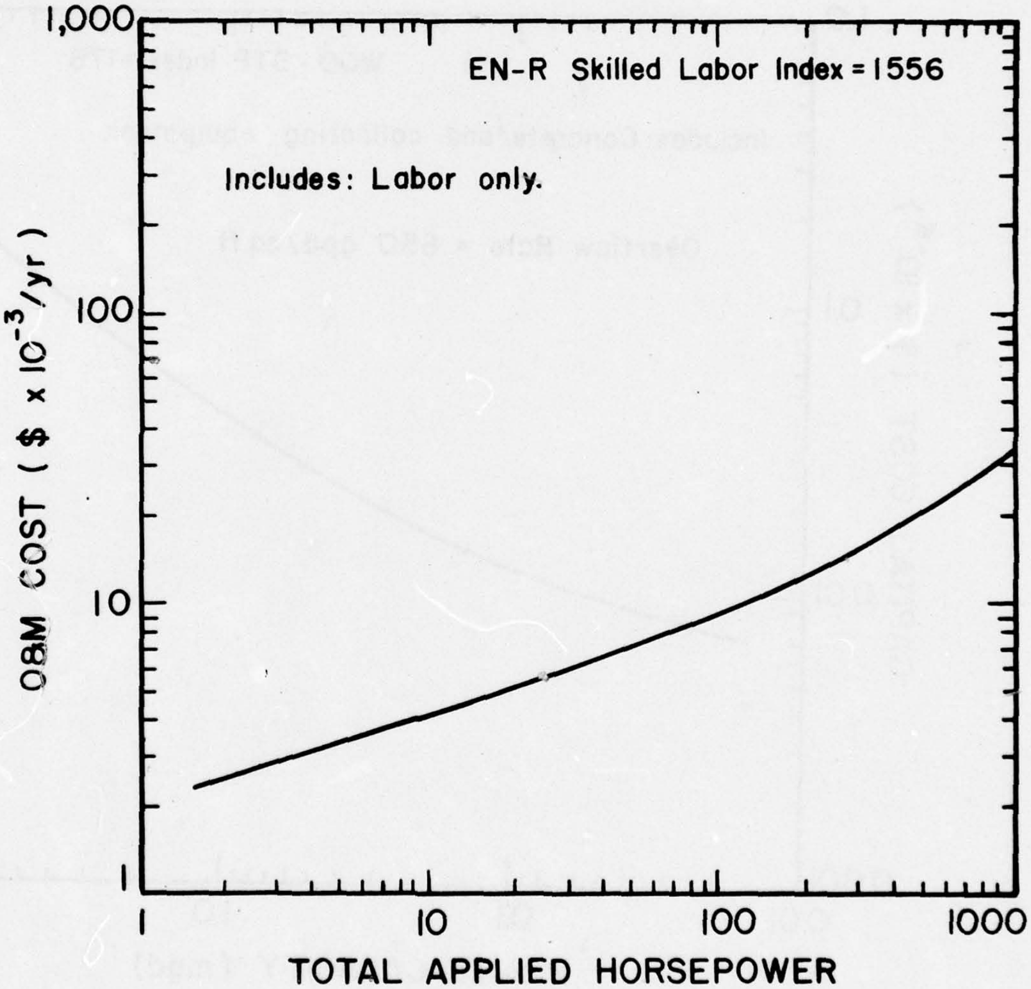

FIG. A-11. OPERATION AND MAINTENANCE COST OF MECHANICAL AERATION

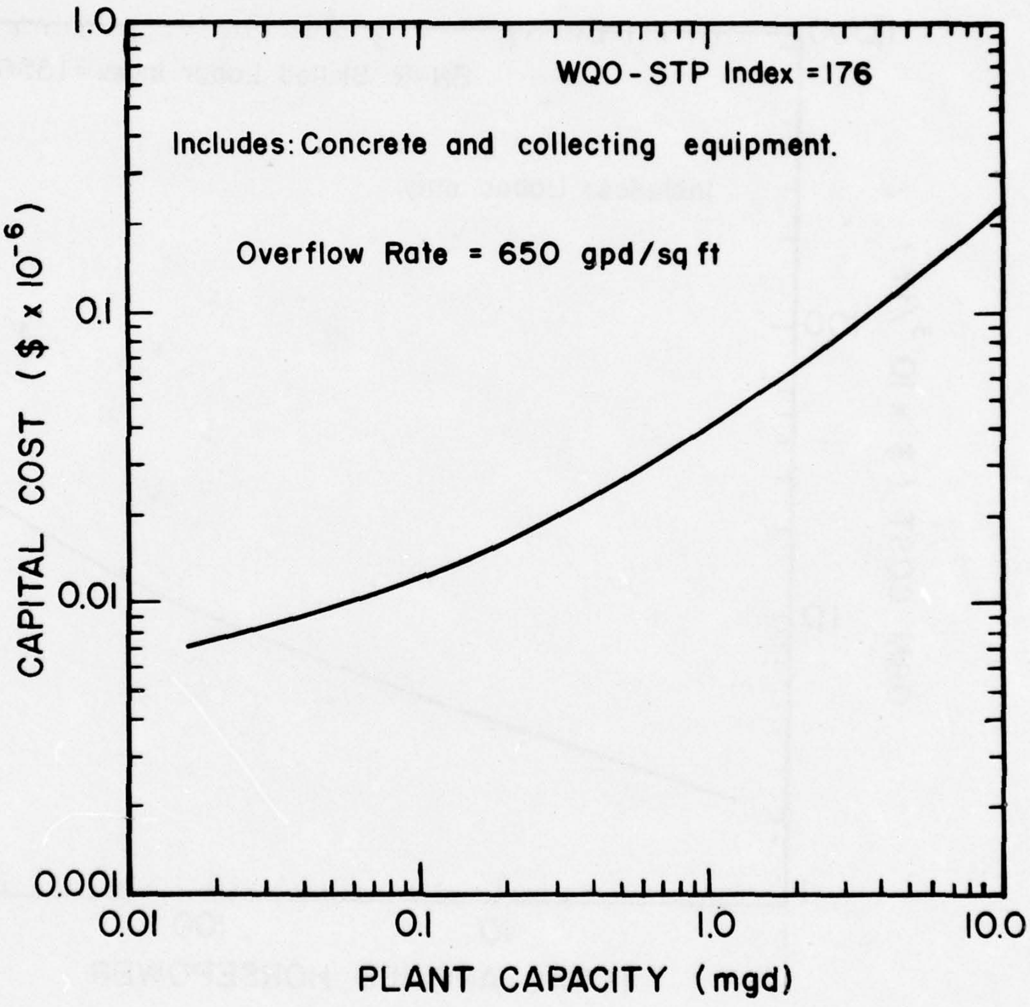

FIG. A-12. CAPITAL COST OF SECONDARY CLARIFICATION

A-13. These relationships were obtained from Di Gregorio [51] and Patterson [41], respectively and were based on an overflow rate of 650 gpd/sq ft. The capital cost model includes concrete and collecting equipment; the operation and maintenance cost model includes labor, materials and supplies.

Coagulation

The capital cost of adding rapid mix and flocculation facilities to an existing waste water treatment plant is presented in Figure A-14. This cost includes the rapid mix basin, mixer, and baffles added to an existing circular settling basin. The estimated initial total cost of adding lime feed facilities to an existing waste water treatment plant is presented in Figure A-15. Included in this cost is equipment for feeding 150 to 300 mg/l of lime. The building, instrumentation, and piping are not included in the cost.

The capital costs of lime treatment faiclities are presented in Figure A-16. The costs include a lime slaker, rapid mix, flocculator, sedimentation, and recarbonation. Sludge disposal or recalcination are not included.

The FOB costs of several chemicals commonly used in waste water treatment are presented in Figure A-17. Other operating and maintenance costs are shown in Figure A-18.

Ion Exchange

The cost of ion exchange plants is dependent on the total volume of waste treated, but also to a large extent on the total amount of dissolved solids removed or exchanged since the flowrate through the

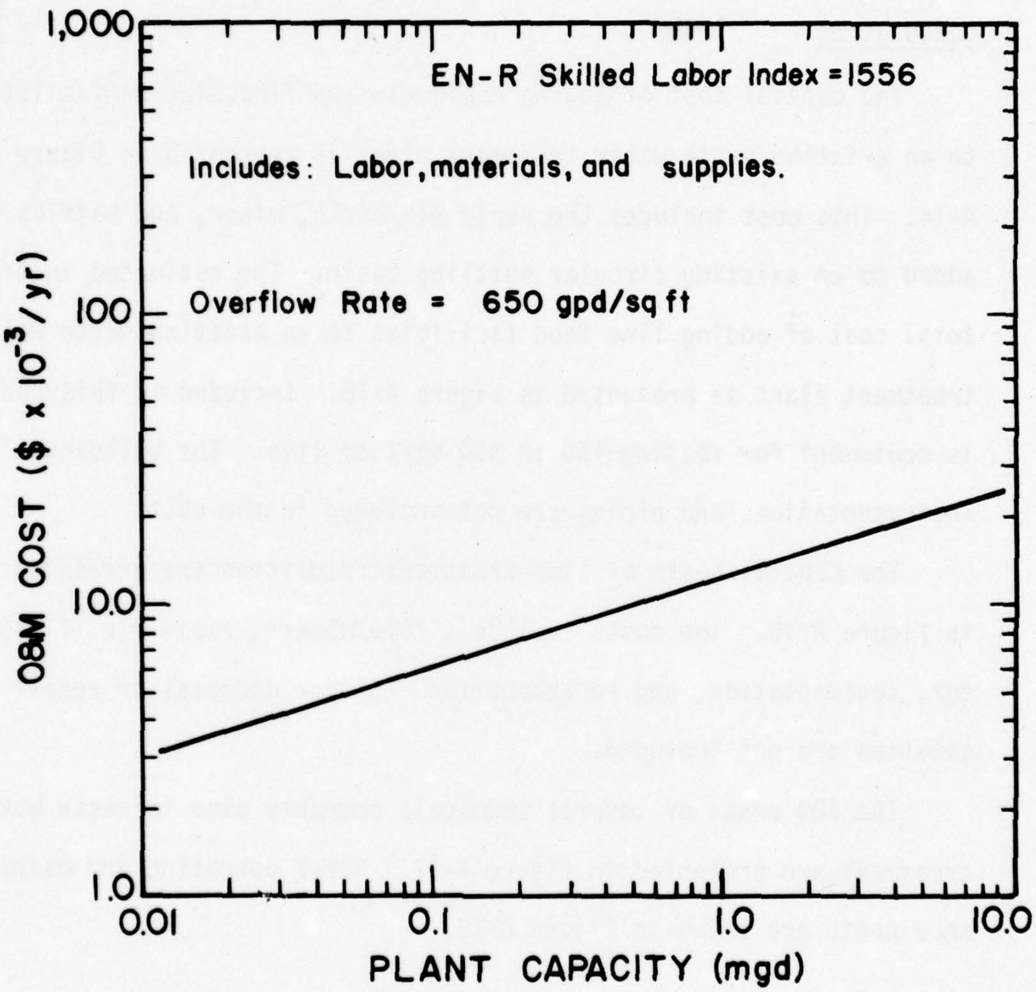

FIG. A-13. OPERATION AND MAINTENANCE COST OF SECONDARY CLARIFICATION

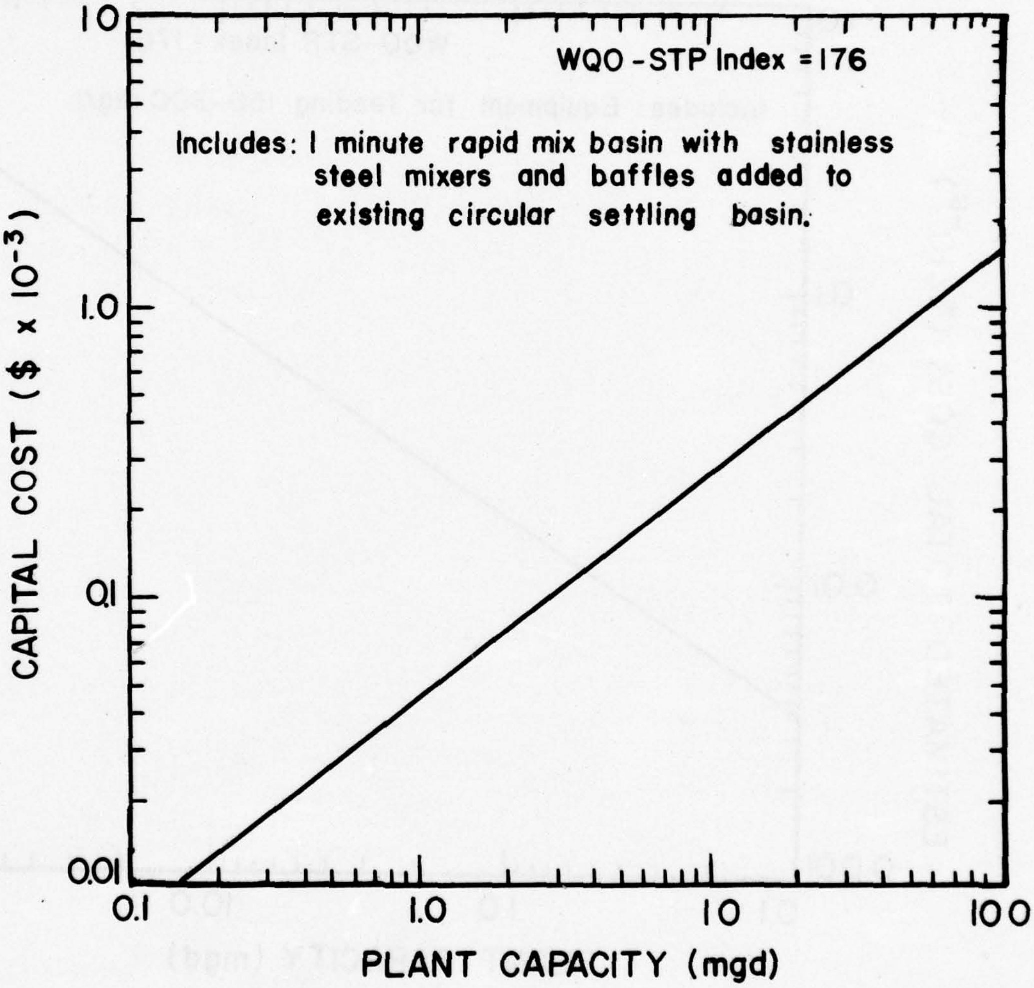

FIG. A-14. CAPITAL COST OF ADDING RAPID MIX AND FLOCCULATION FACILITIES

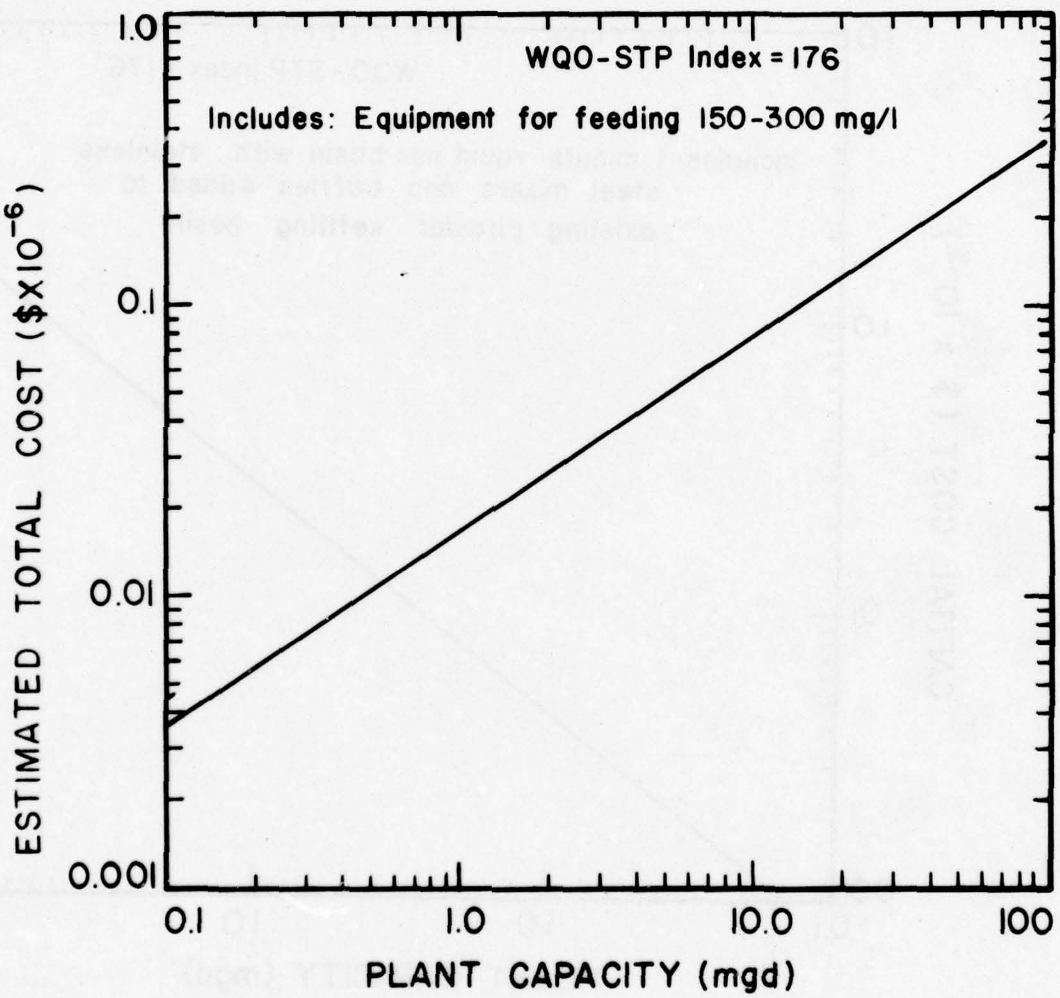

FIG. A-15. ESTIMATED INITIAL TOTAL COST OF ADDING LIME FEED FACILITIES TO EXISTING WASTEWATER TREATMENT PLANTS

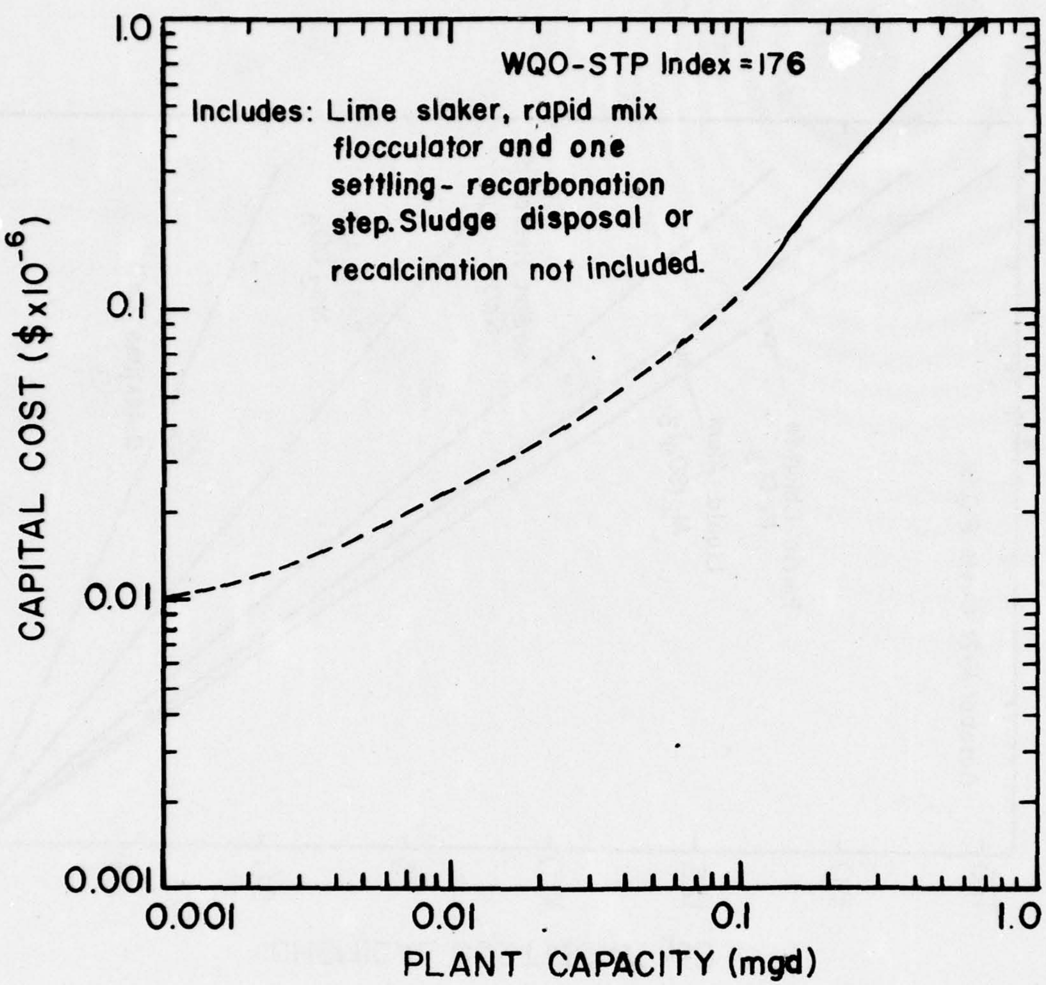

FIG. A-16. CAPITAL COST OF LIME TREATMENT FACILITIES

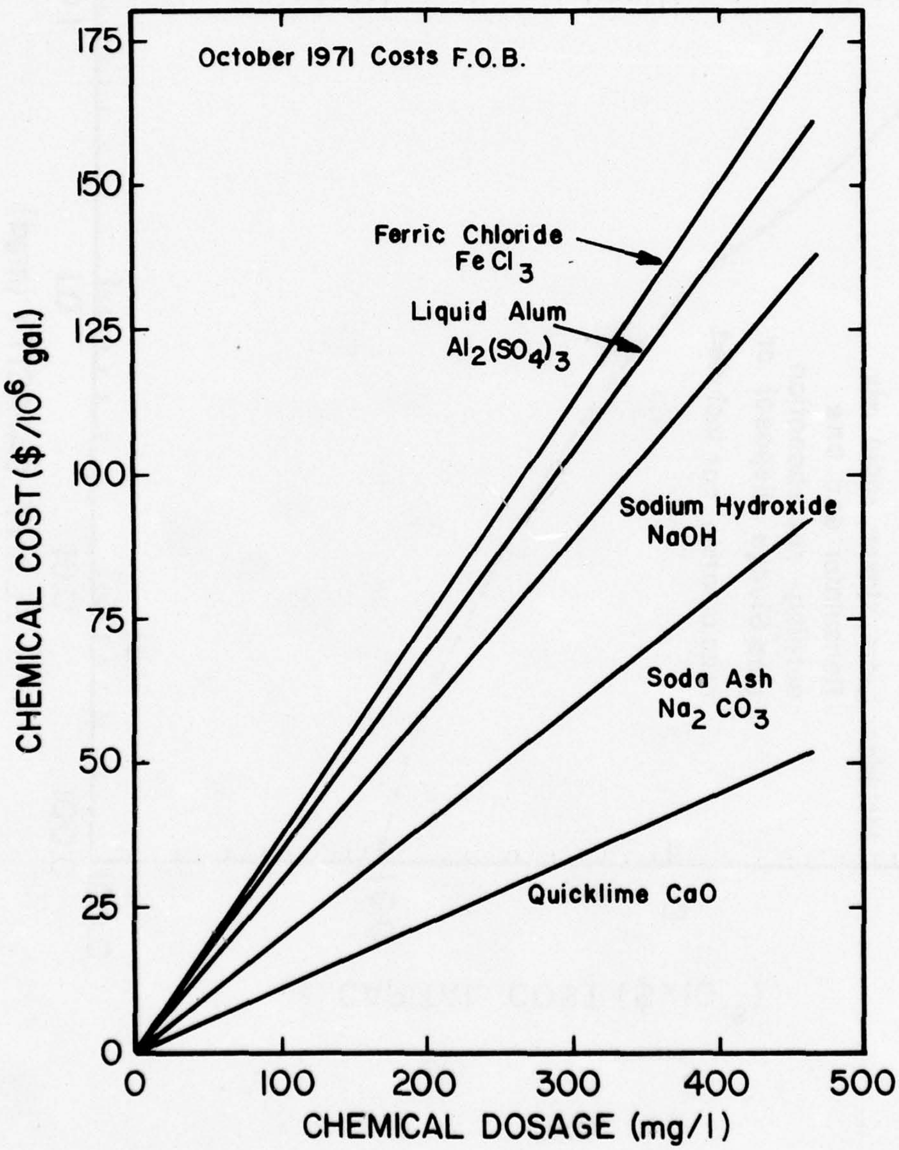

FIG. A-17. COST OF CHEMICAL ADDITION

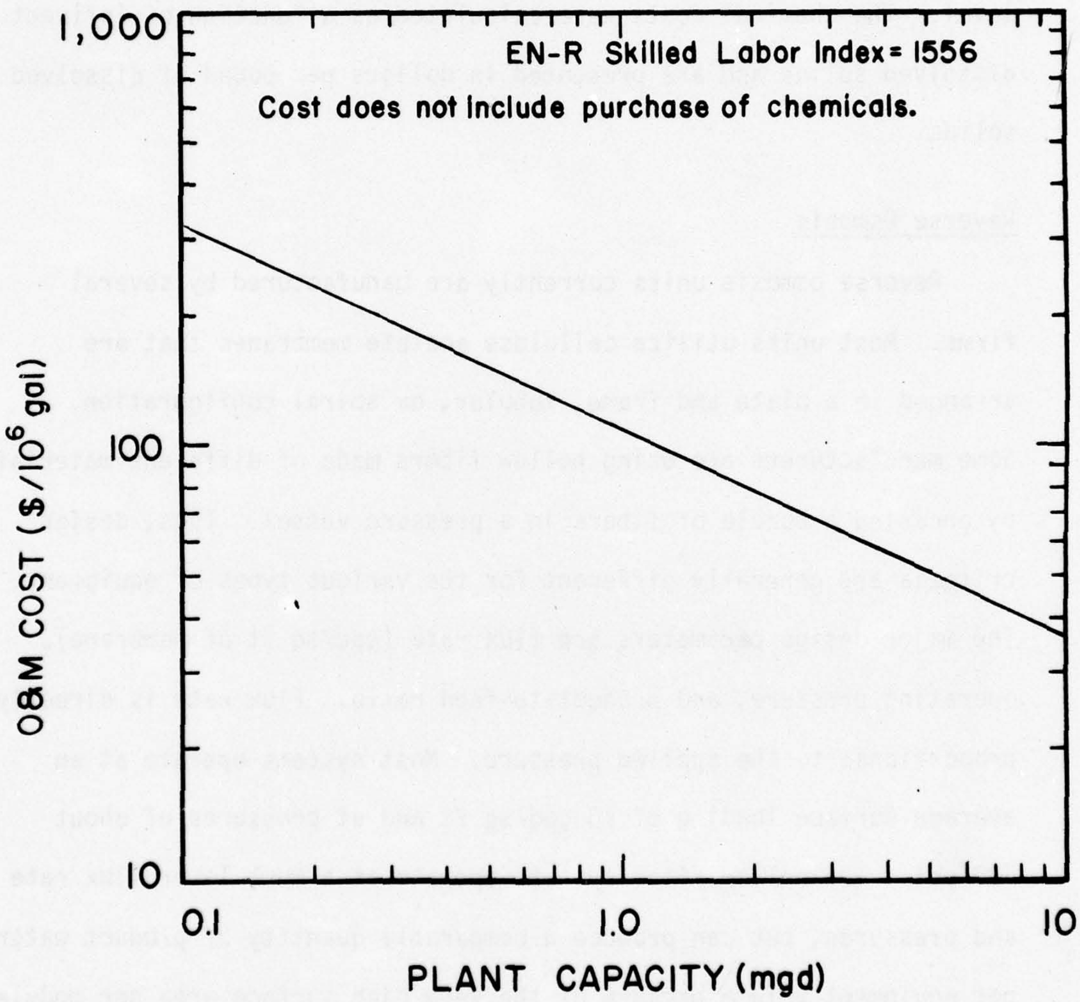

FIG. A-18. OPERATION AND MAINTENANCE COSTS FOR CHEMICAL PRECIPITATION

media remains fairly constant. Figures A-19 through A-21 present the capital cost, chemical cost, and other operating costs for demineralization by ion exchange found in the study of the inorganic chemicals industry [1]. The capital cost is presented on the basis of flow in million gallons per day and a varying influent total dissolved solids level. The chemical costs were calculated as a function of influent dissolved solids and are presented in dollars per pound of dissolved solids.

Reverse Osmosis

Reverse osmosis units currently are manufactured by several firms. Most units utilize cellulose acetate membranes that are arranged in a plate and frame, tubular, or spiral configuration. Some manufacturers are using hollow fibers made of different materials by encasing a bundle of fibers in a pressure vessel. Thus, design criteria are generally different for the various types of equipment. The major design parameters are flux rate (gpd/sq ft of membrane), operating pressure, and product-to-feed ratio. Flux rate is directly proportional to the applied pressure. Most systems operate at an average surface loading of 10 gpd/sq ft and at pressures of about 500 psi. The hollow fiber systems operate at a much lower flux rate and pressures, but can produce a comparable quantity of product water per equipment volume because of the very high surface area per module ratio associated with the fine fibers. For all types of units, rejected brines may pose a disposal problem, depending on local conditions.

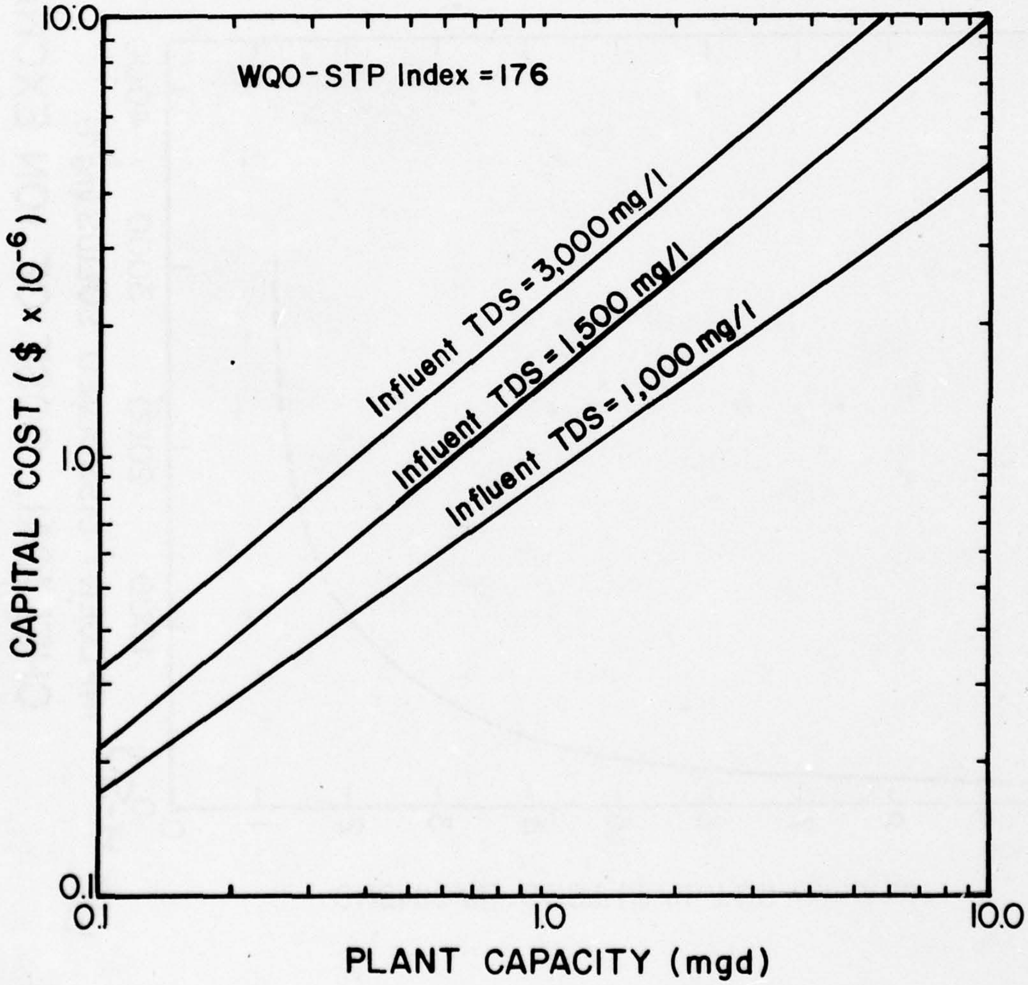

FIG. A-19. CAPITAL COST OF ION EXCHANGE

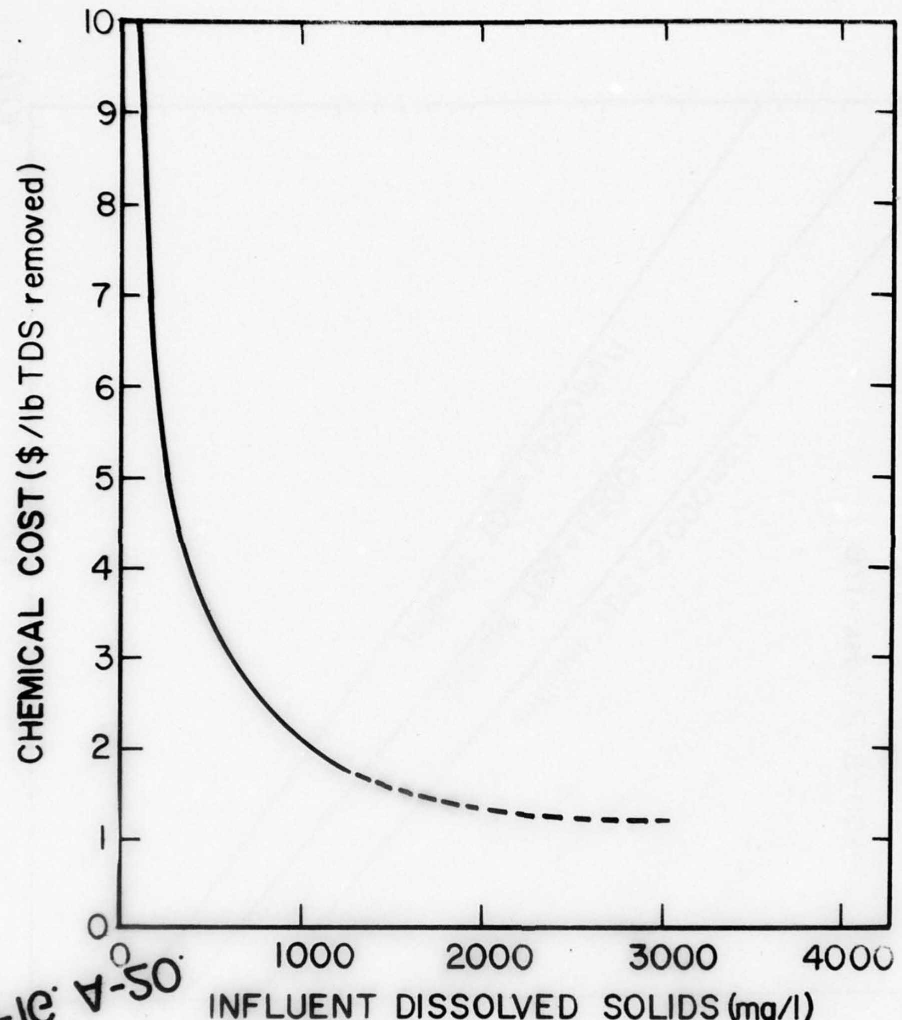

FIG. A-50

CHEMICAL COST OF ION EXCHANGE

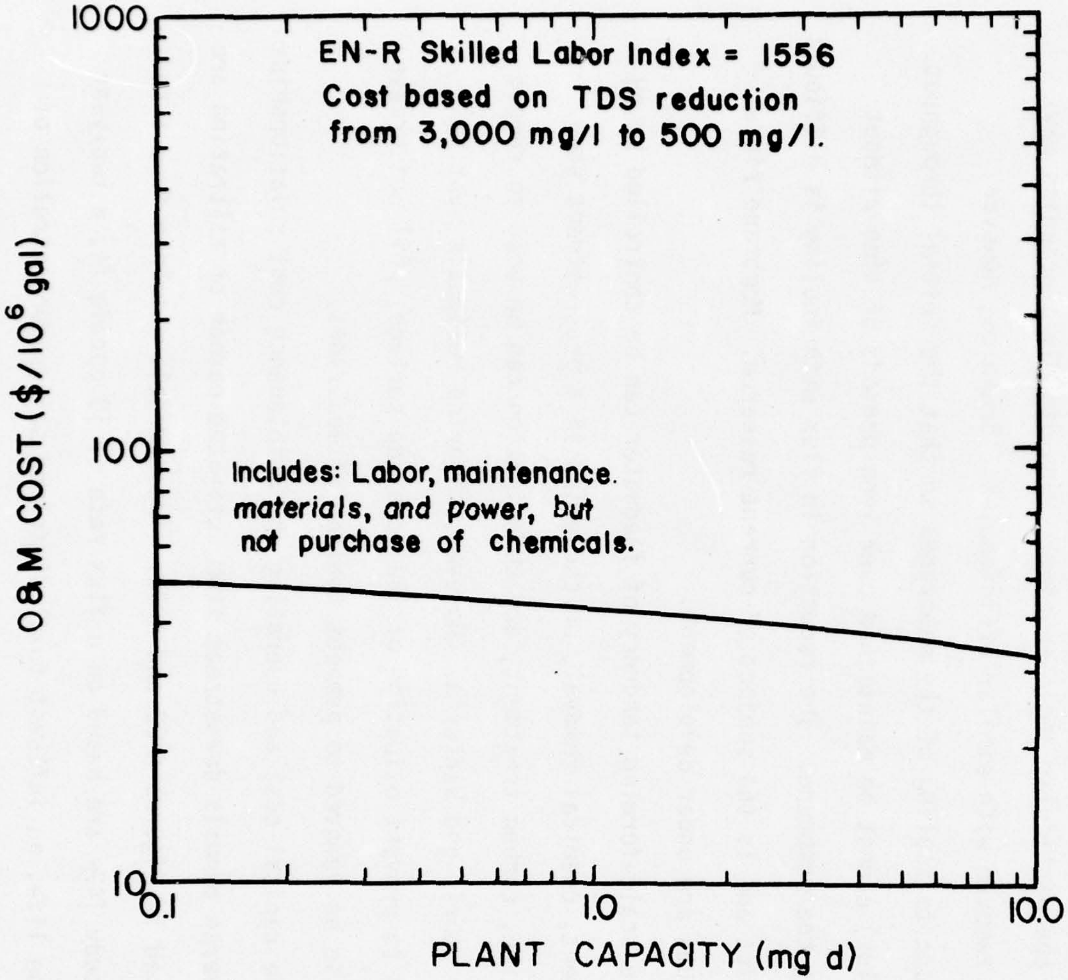

FIG. A-21. OPERATION AND MAINTENANCE COSTS FOR ION EXCHANGE DEMINERALIZATION

Based upon studies to date, reverse osmosis appears to be capable of removing over 90 percent of the dissolved inorganic solvents typically found in a secondary effluent. However, selectivities for the removal of individual ions varies with the chemical characteristics of the particular ionic species. Many dissolved organics may also be removed with similar efficiencies. Organics, however, contribute to fouling of the membranes so that the initial throughput rate (flux) cannot be maintained over long periods of time without cleaning the membrane. The reduction in flux with fouling is difficult to predict and is the subject of current research. Membrane rinse techniques are under development.

The scale-forming tendency of feedwater can be controlled by pH adjustment, chemical removal, or chelating in a pretreatment step. Filtration, carbon treatment, and chlorination can be used to remove organic debris and bacteria. However, chlorine residuals must be removed to prevent oxidation of the membrane surface. Oil and grease must also be removed to prevent fouling of membranes.

The capital ocst and operating and maintenance cost relationships for reverse osmosis downstream from activated carbon or filtration are presented in Figures A-22 and A-23. These models obtained from a recent study [47] are based on a flux rate of 10 gpd/sq ft, a two-year membrane life, an influent total dissolved solids concentration of 700 mg/l and a product total dissolved solids of 100 mg/l with 15 percent brine. However, costs presented in a report of wastewater treatment in the inorganic chemicals industry [1] and conversations with manufacturers of reverse osmosis equipment confirmed that these cost

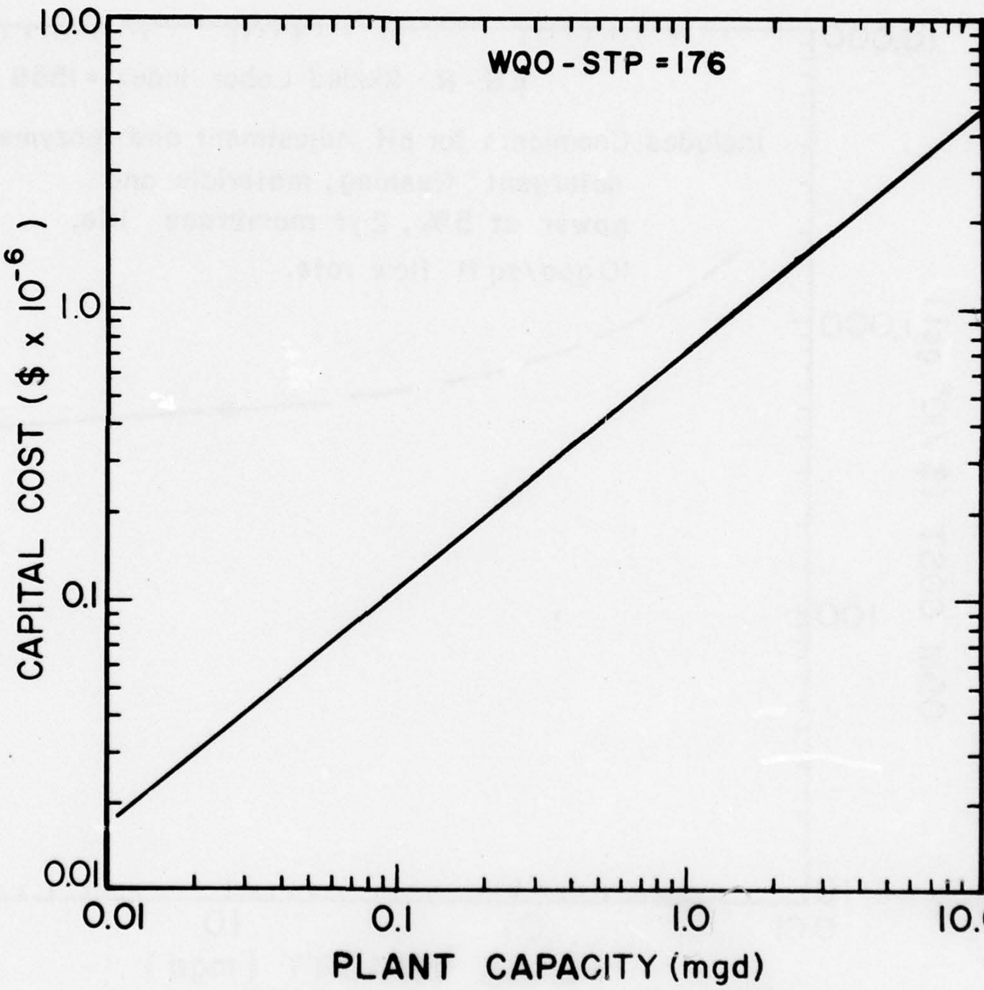

FIG. A-22. CAPITAL COST OF REVERSE OSMOSIS DOWNSTREAM FROM ACTIVATED CARBON OR FILTRATION

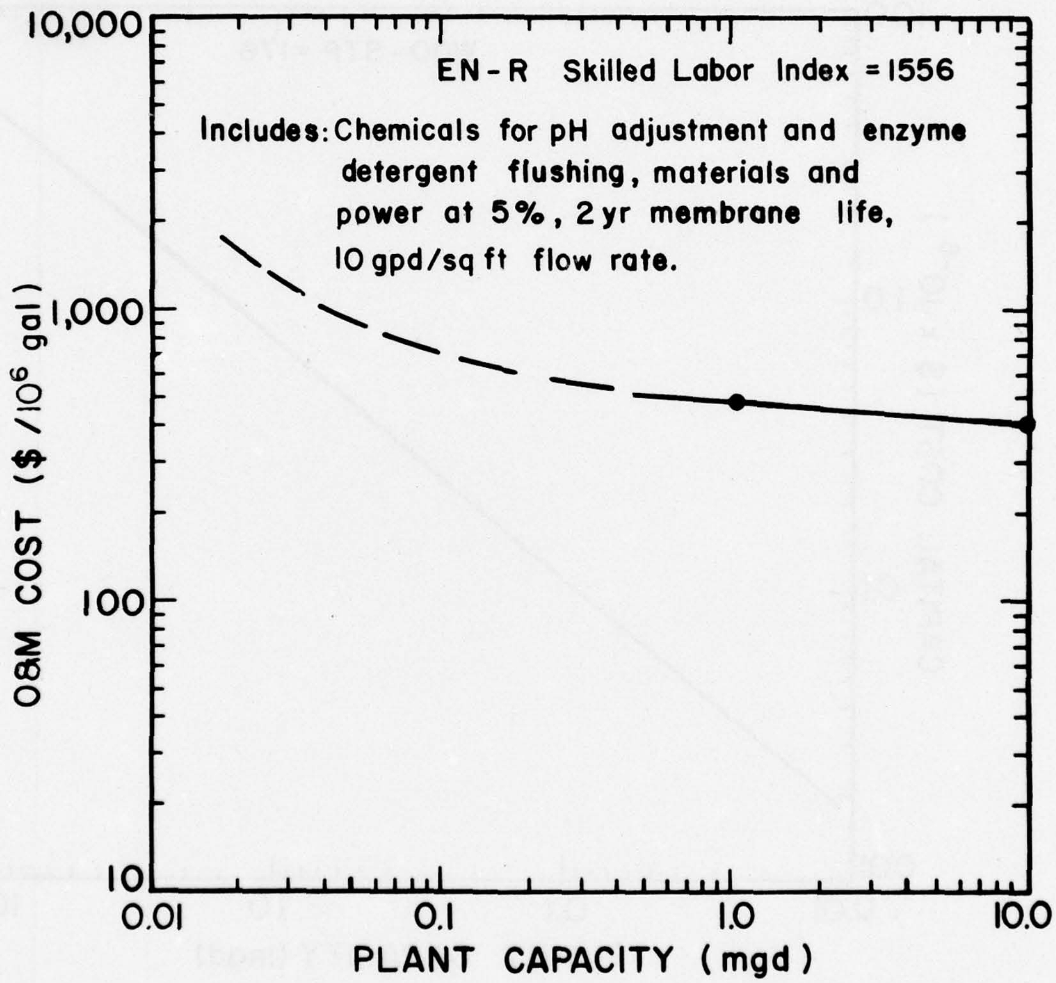

FIG. A-23. OPERATION AND MAINTENANCE COST FOR REVERSE OSMOSIS DOWNSTREAM FROM ACTIVATED CARBON OR FILTRATION

figures would also be valid for influent TDS concentrations up to approximately 3,000 mg/l.

Included in the model are chemicals for pH adjustment and enzyme detergent flushing maintenance materials, membrane replacement, and power costs.

Deep Well Disposal

Deep well disposal was considered as a means for disposal of brine solutions from demineralization processes. Costs were obtained from studies of waste treatment practices in the organic and inorganic chemicals industries [1, 52]. The capital cost relationship, presented in Figure A-24, is for an injection pressure of 900 psi and includes filtration as pretreatment. However, in many cases filtration might not be required. The operation and maintenance cost, shown in Figure A-25, are for the equipment specified above and presumably include power, labor, and maintenance materials costs.

Evaporation

Costs for evaporation, shown in Figure A-26, were estimated by contacting manufacturers of this equipment. Estimates were based on two loop systems including concentration to approximately 100 g/l in the first loop and crystallization in the second loop. Although costs of these units may vary by 300 to 400 percent depending on the corrosive nature of the sludge, its moisture retention tendency, etc., estimates were based on sludges which would not easily corrode equipment but which would not crystallize at a high moisture content.

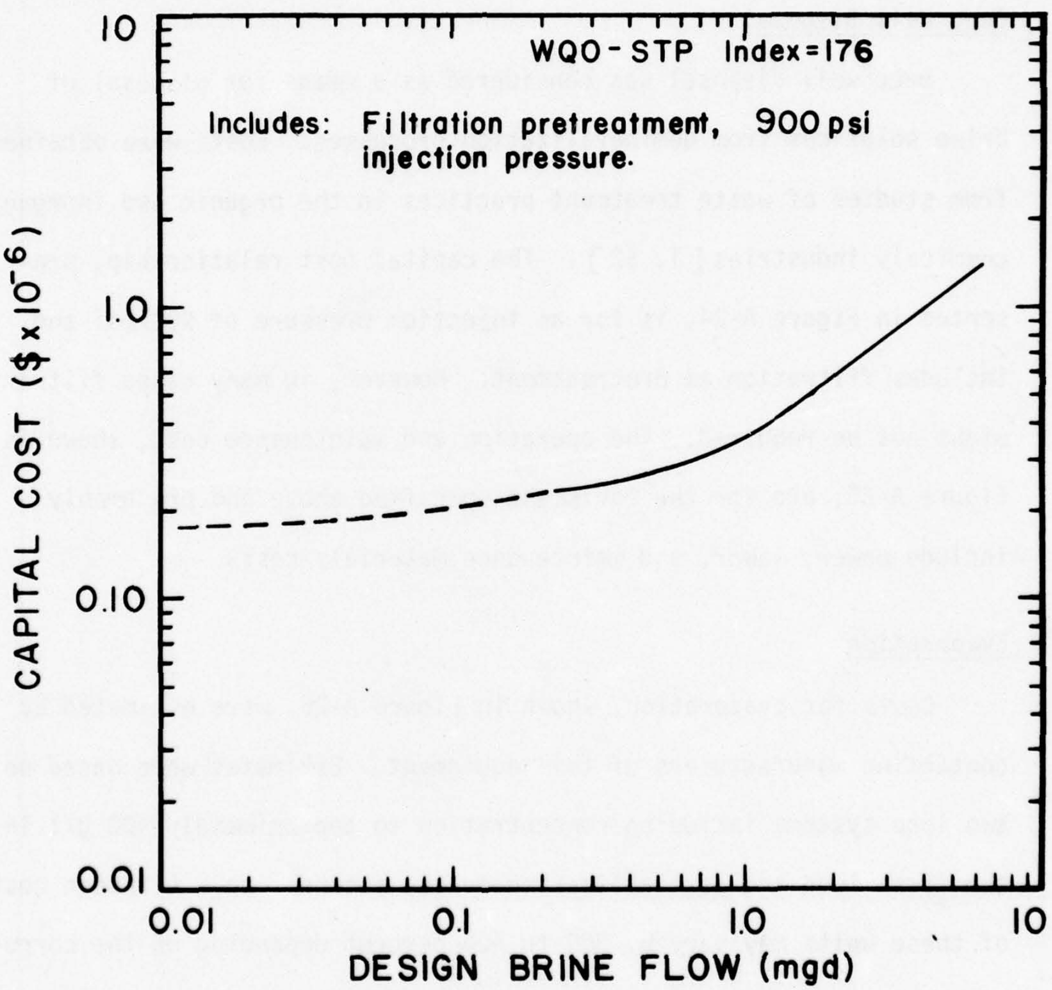

FIG. A-24. CAPITAL COST OF DEEP WELL INJECTION SYSTEMS

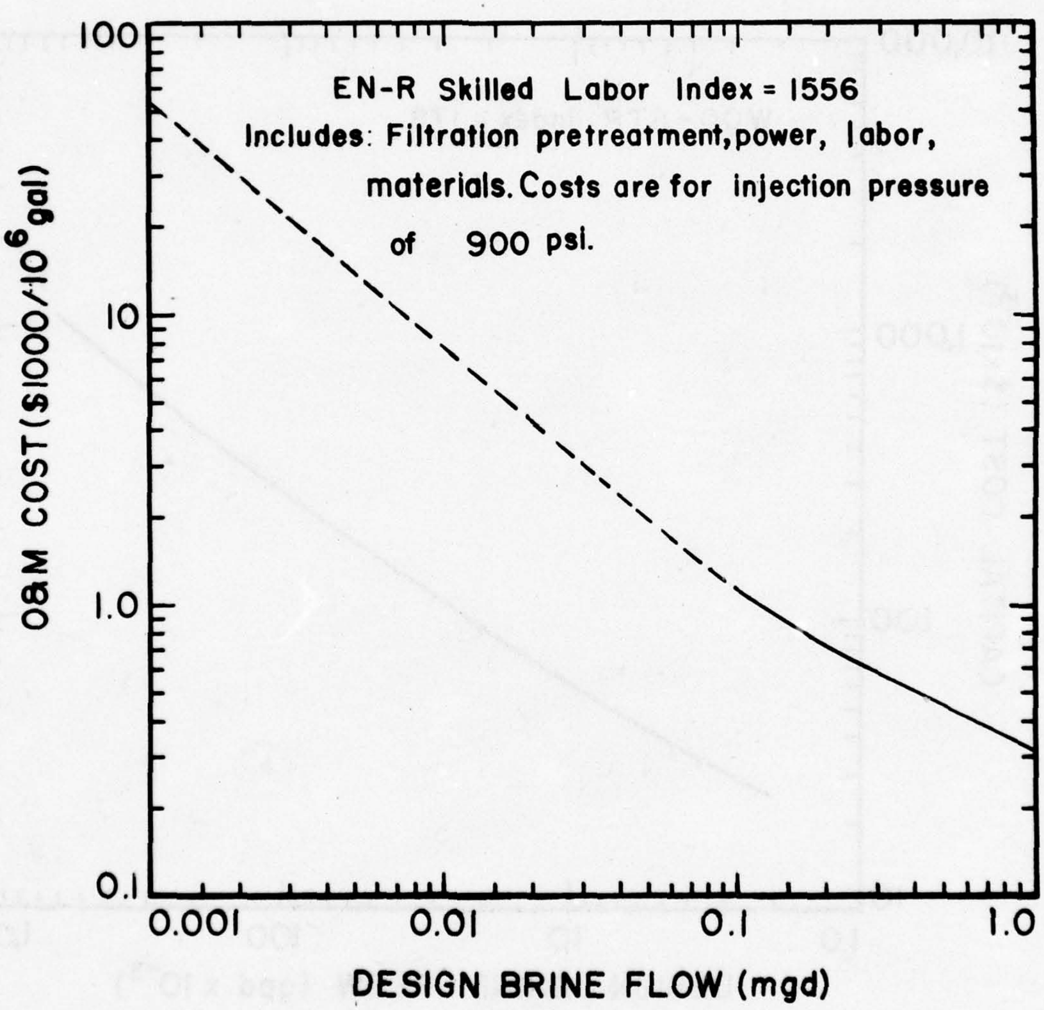

FIG. A-25. OPERATION AND MAINTENANCE COSTS FOR DEEP WELL INJECTION SYSTEMS

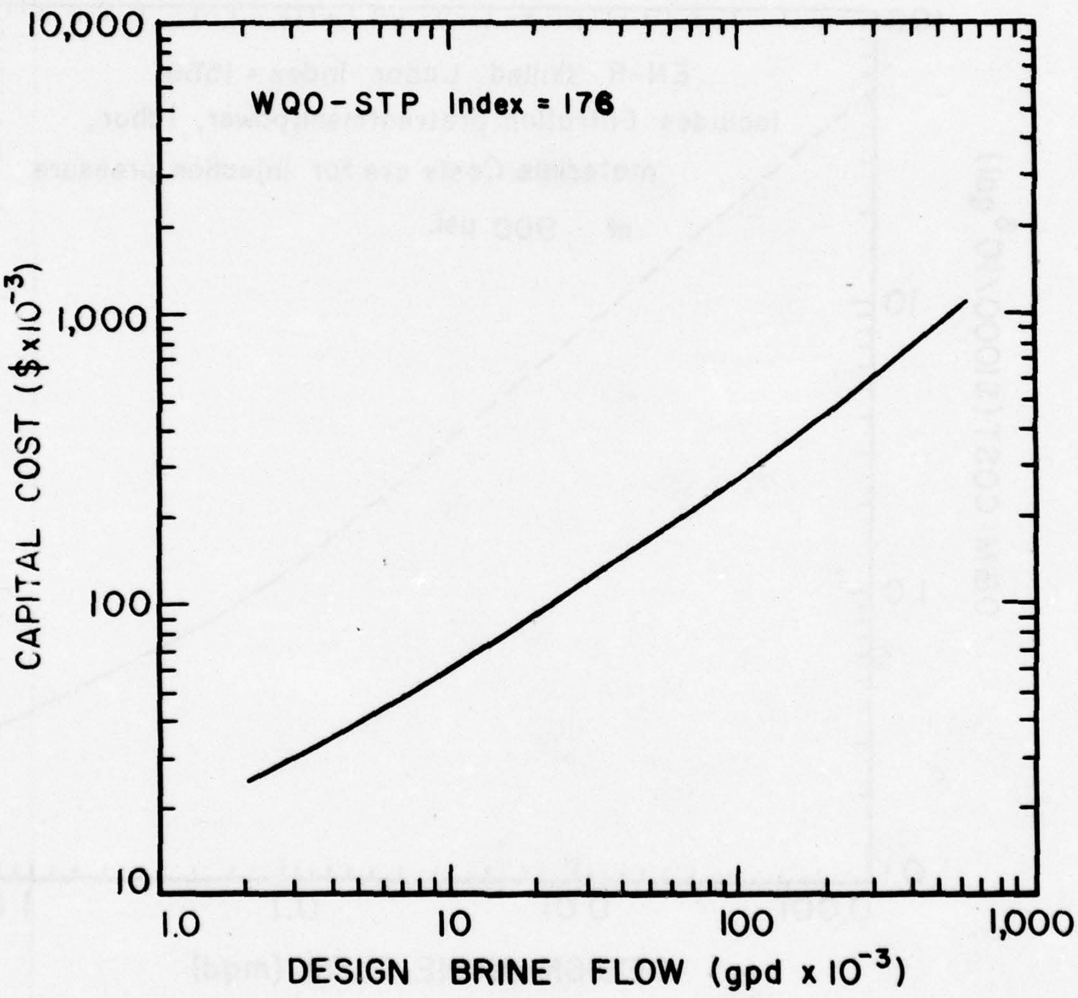

FIG. A-26. CAPITAL COST OF BRINE EVAPORATION

Operation and maintenance costs are shown in Figure A-27. While no facilities for steam generation were included in the capital cost relationship, allowance was made in operation and maintenance costs for the purchase of required steam at $0.50/10^6 BTU.

Sand Filtration

Sand filters are designed mainly on the basis of hydraulic loading. Most operate in the range of 2 to 8 gpm/sq ft. Filtered effluent is usually used for backwash water; backwash rates of 50 gpm/sq ft are standard. The effective size of the sand is normally in the range of 0.5 to 2.0 mm. Sand depth is usually 24 to 30 in. over a gravel bed or porous plate support. The capital cost and operation and maintenance costs relationships for sand filtration for graded medium filtration at a flow rate of 4 gpm/sq ft are presented in Figures A-28 and A-29. These were obtained from a study of various filtration processes prepared for the U. S. Army Corps of Engineers [45].

Flotation

The principal components in a flotation system are: 1) a pump to increase pressures for greater air solubility, 2) a retention tank where air and liquid are mixed under pressure for one to two minutes, 3) a pressure release valve, and 4) the flotation unit including a sludge withdrawal mechanism.

The capital cost relationship for air flotation is presented in Figure A-30 and was obtained from a study of the organic chemicals industry [52]. In the absence of more definitive data, operation and maintenance costs exclusive of chemicals were assumed to be the same

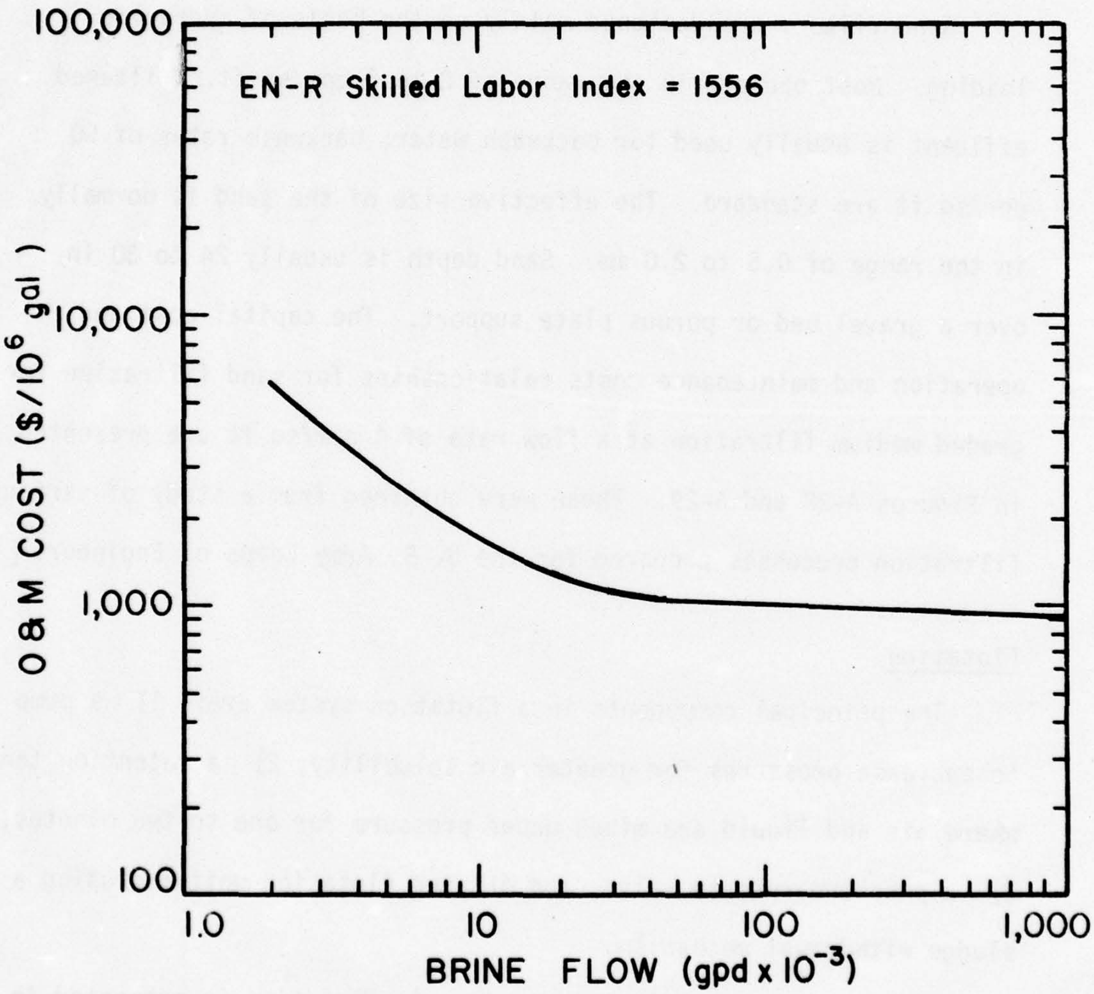

FIG. A-27. OPERATION AND MAINTENANCE COSTS FOR BRINE EVAPORATION

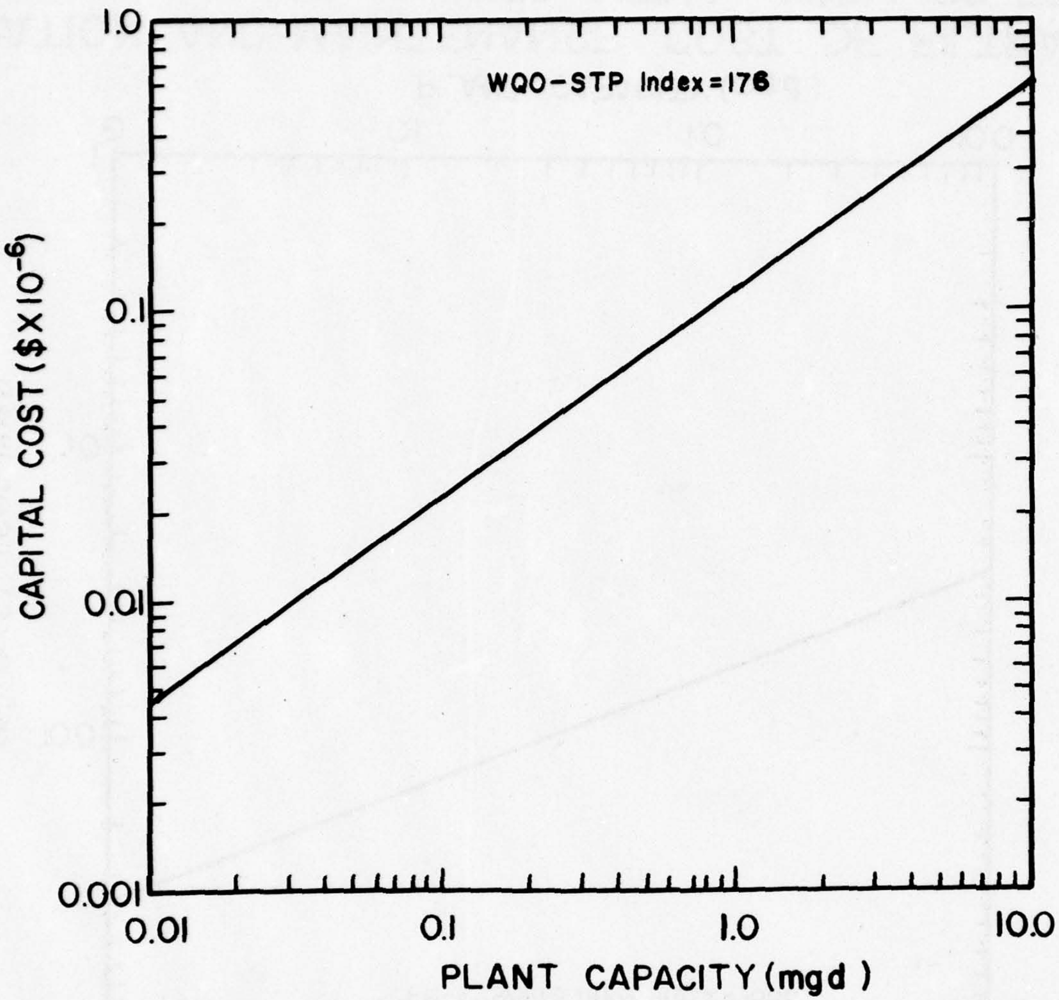

FIG. A-28. CAPITAL COST OF FILTRATION THROUGH SAND OR GRADED MEDIA — 4 GPM / SQ FT

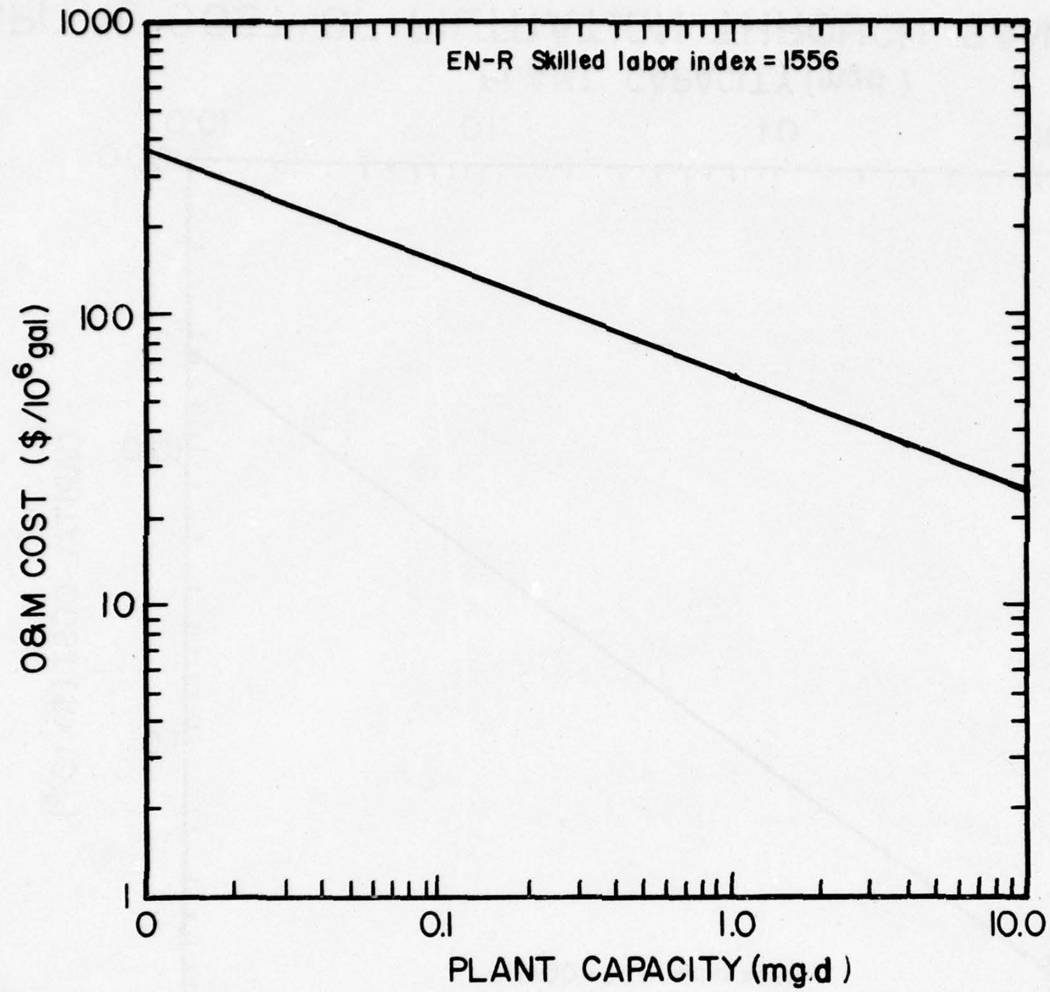

FIG. A-29. OPERATION AND MAINTENANCE COST OF FILTRATION THROUGH SAND OR GRADED MEDIA - 4 GPM/SQ FT

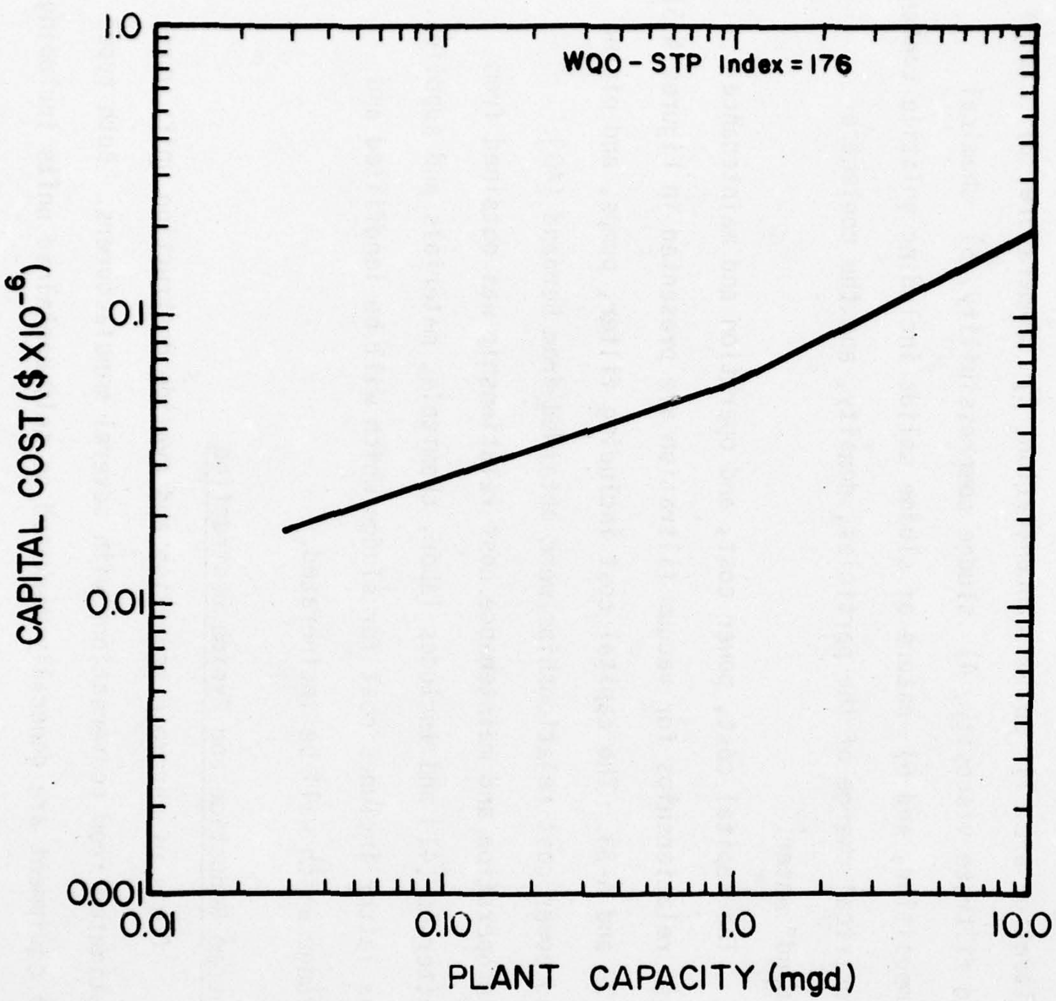

FIG. A-30. CAPITAL COST OF DISSOLVED AIR FLOATATION

as for chemical coagulation although it is recognized that operational costs for dissolved air flotation may exceed those for coagulation.

Vacuum Filtration

Factors that effect the ability to dewater sludge by vacuum filtration are: 1) solids concentration, 2) temperature, 3) sludge and filtrate viscosity, 4) sludge compressibility, 5) chemical composition, and 6) nature of sludge solids including volatile content electrical charge of the particles, density, and the content of "bound" water.

The capital cost, power cost, and operation and maintenance cost relationships for vacuum filtration are presented in Figures A-31 A-32 and A-33. The capital cost including filter, pumps, and piping and power cost relationships were obtained from Bernand [40]. The operation and maintenance cost relationship was obtained from Patterson [41] and includes labor, chemicals, materials and supplies. The latter includes cost for sludge which will be landfilled and sludge which will be incinerated.

Chrome Reduction and Cynide Destruction

Costs of chromate reduction and cyanide destruction units were estimated from conversations with several manufacturers. Both types of equipment are generally marketed as self-contained units including necessary instrumentation, treatment vessels, chemical storage tanks, internal valves and piping, and chemical feed systems. Additional allowances were made for influent pumping (not always required), installation, and minimal piping between between treatment units. All

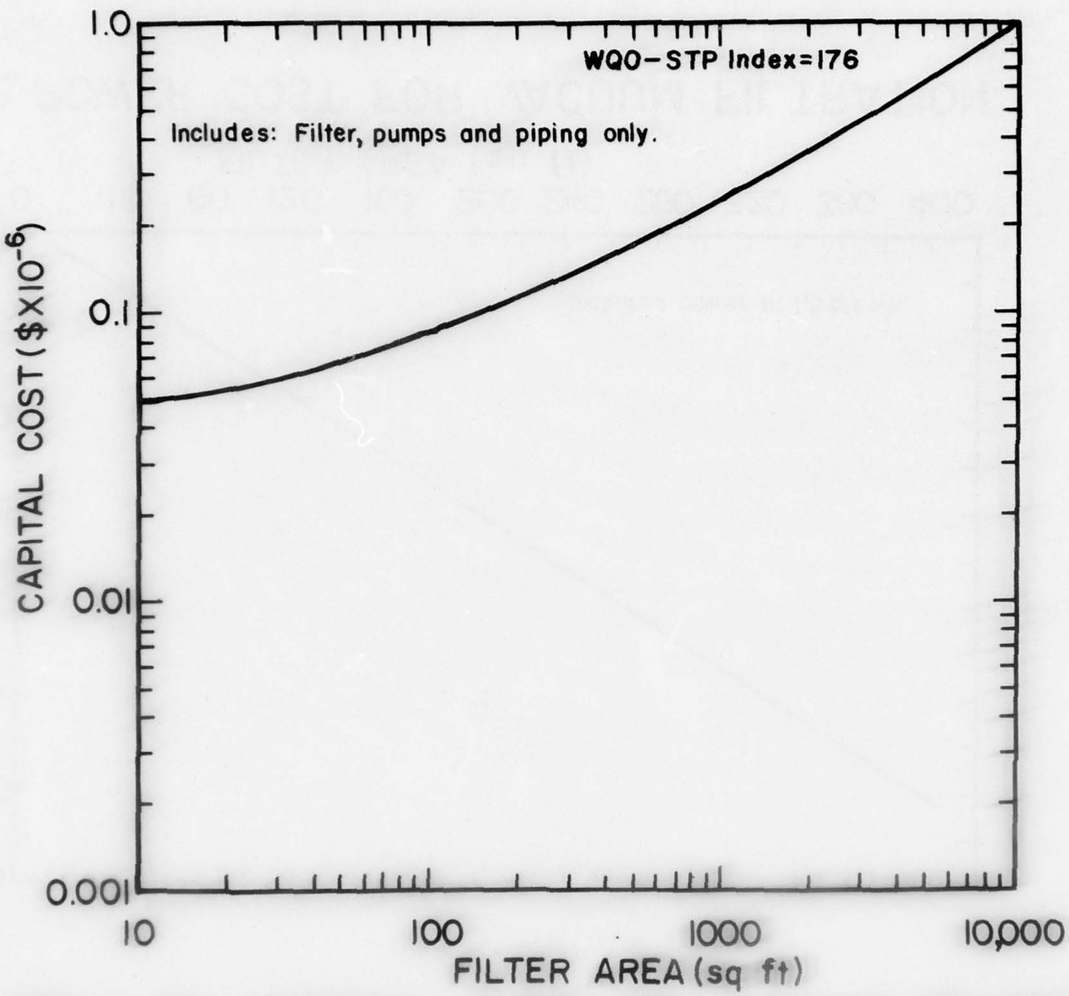

FIG. A-31. CAPITAL COST OF VACUUM FILTRATION

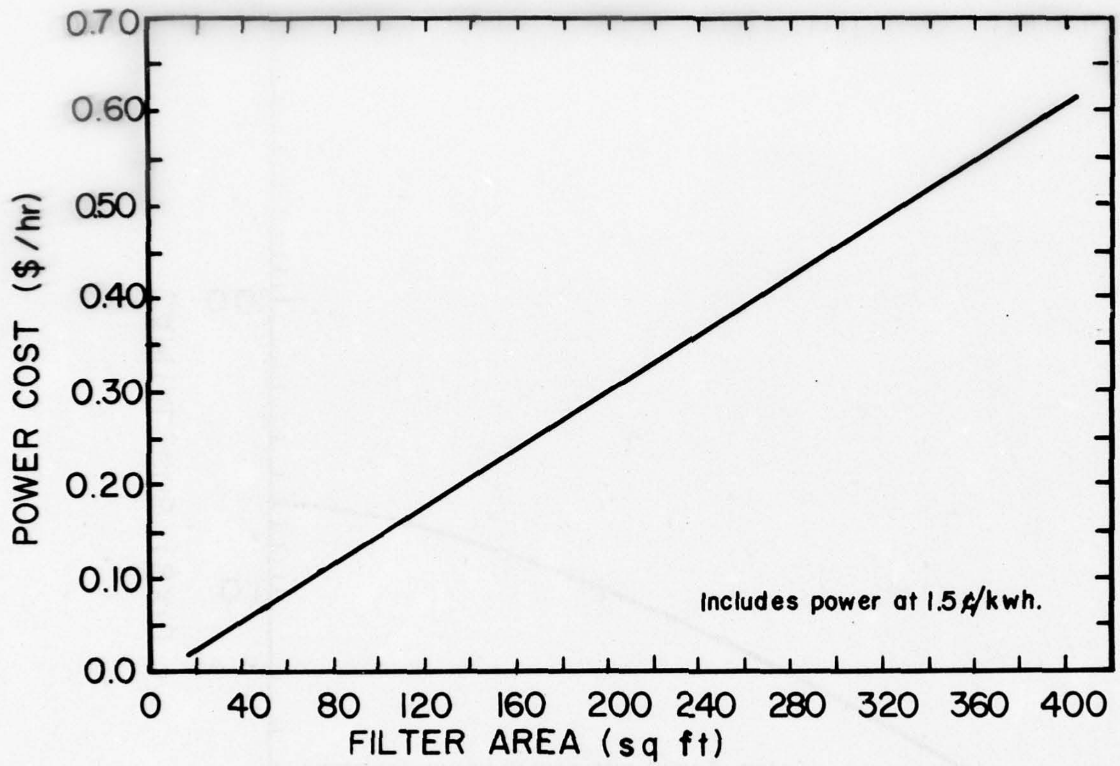

FIG. A-32. POWER COST FOR VACUUM FILTRATION

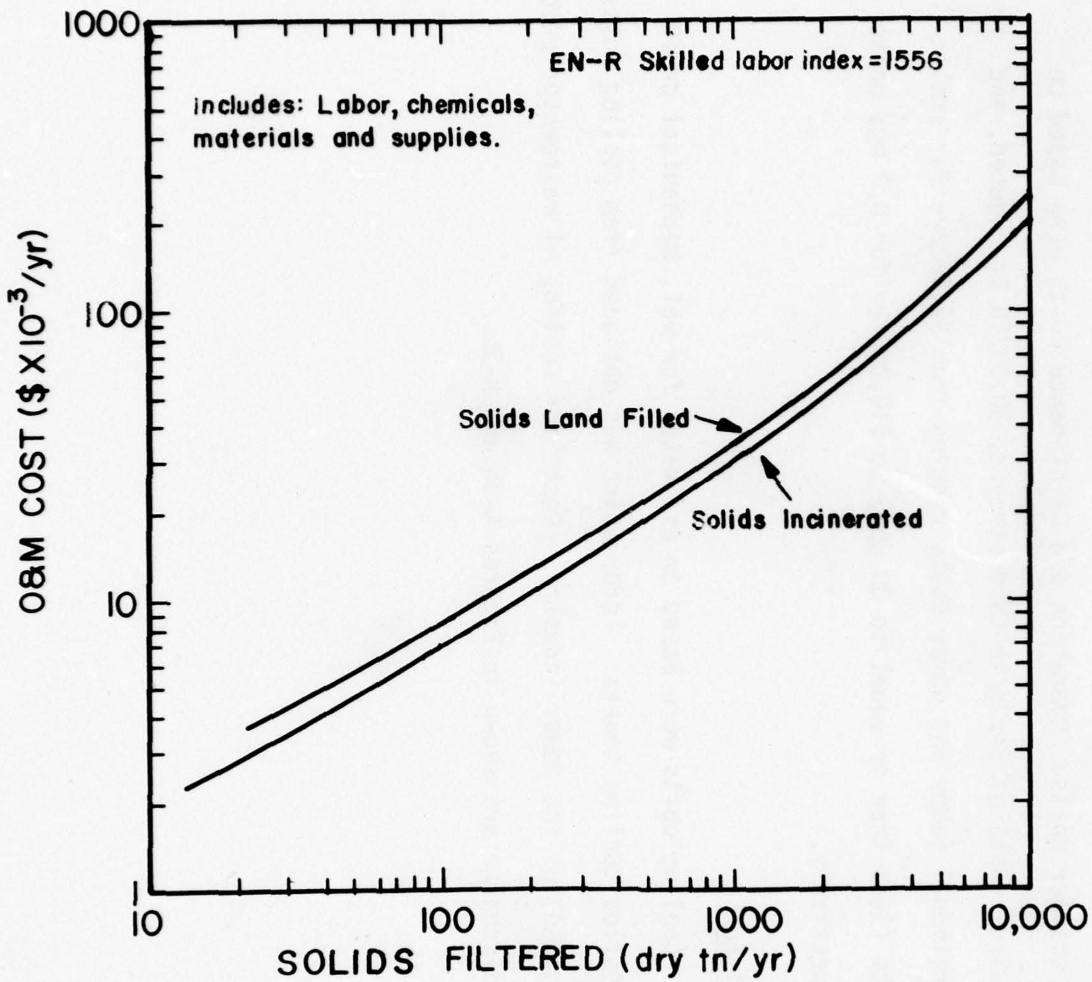

FIG. A-33. OPERATION AND MAINTENANCE COST FOR VACUUM FILTRATION

manufacturers reported little, if any, difference in costs for chrome reduction and cyanide destruction units; therefore, costs for either treatment scheme are represented by one relationship. The capital cost relationship is shown in Figure A-34. The high degree of instrumentation required in these units is evidenced by the flat-sloped curve for smaller units. Operation and maintenance costs were based on chemical costs of \$1.35/lb CN destroyed, \$0.30/lb Cr reduced, and operational labor and power costs ranging from \$2,500/yr for small units (less than or equal to 30 gpm) to \$10,000/yr for 0.3 mgd units, respectively.

Cooling

Cooling costs were based on estimates for wet, mechanical draft crossflow cooling towers. Information was obtianed from cooling costs reported for the power industry. Costs for cooling of wastewater prior to discharge are shown in Figures A-35 and A-36.

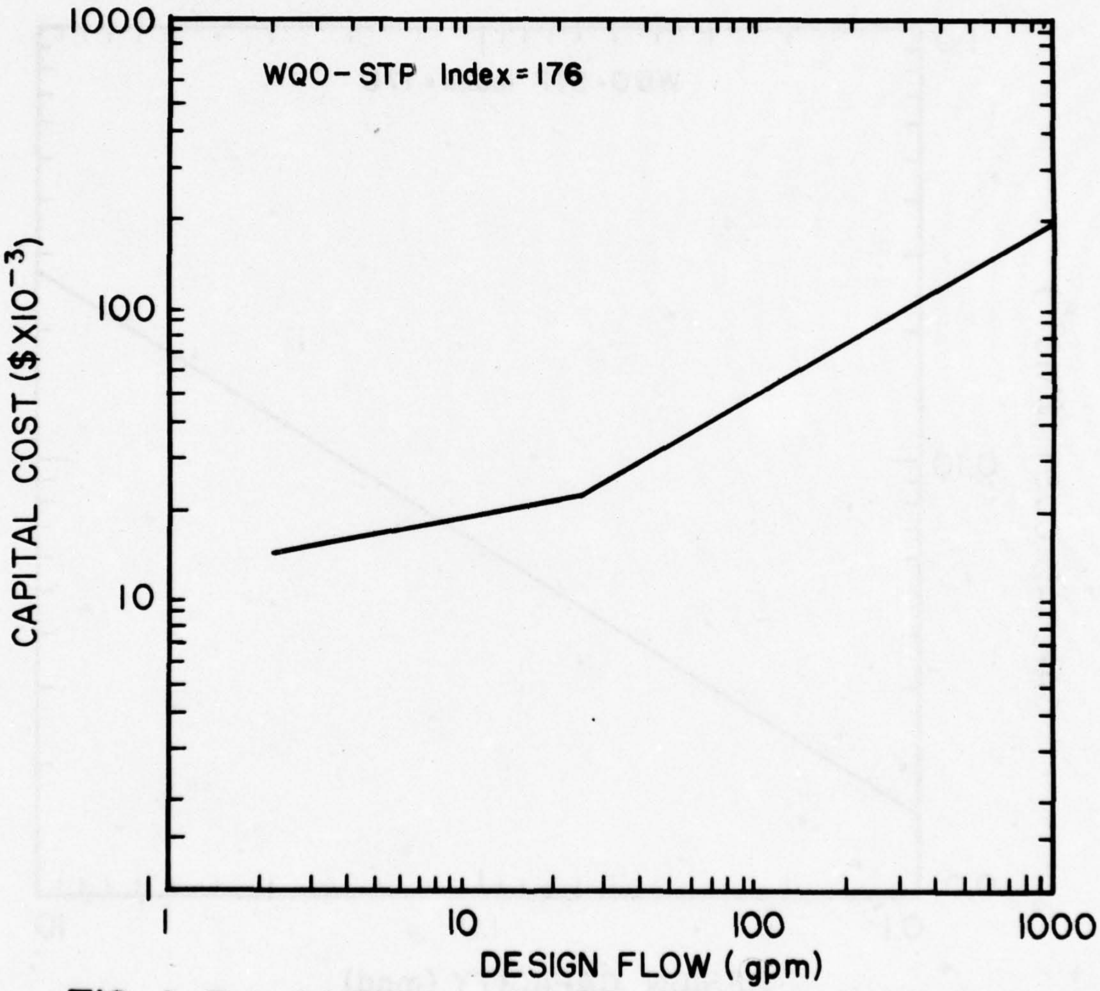

FIG. A-34. CAPITAL COST OF CHROME REDUCTION AND CYANIDE DESTRUCTION UNITS

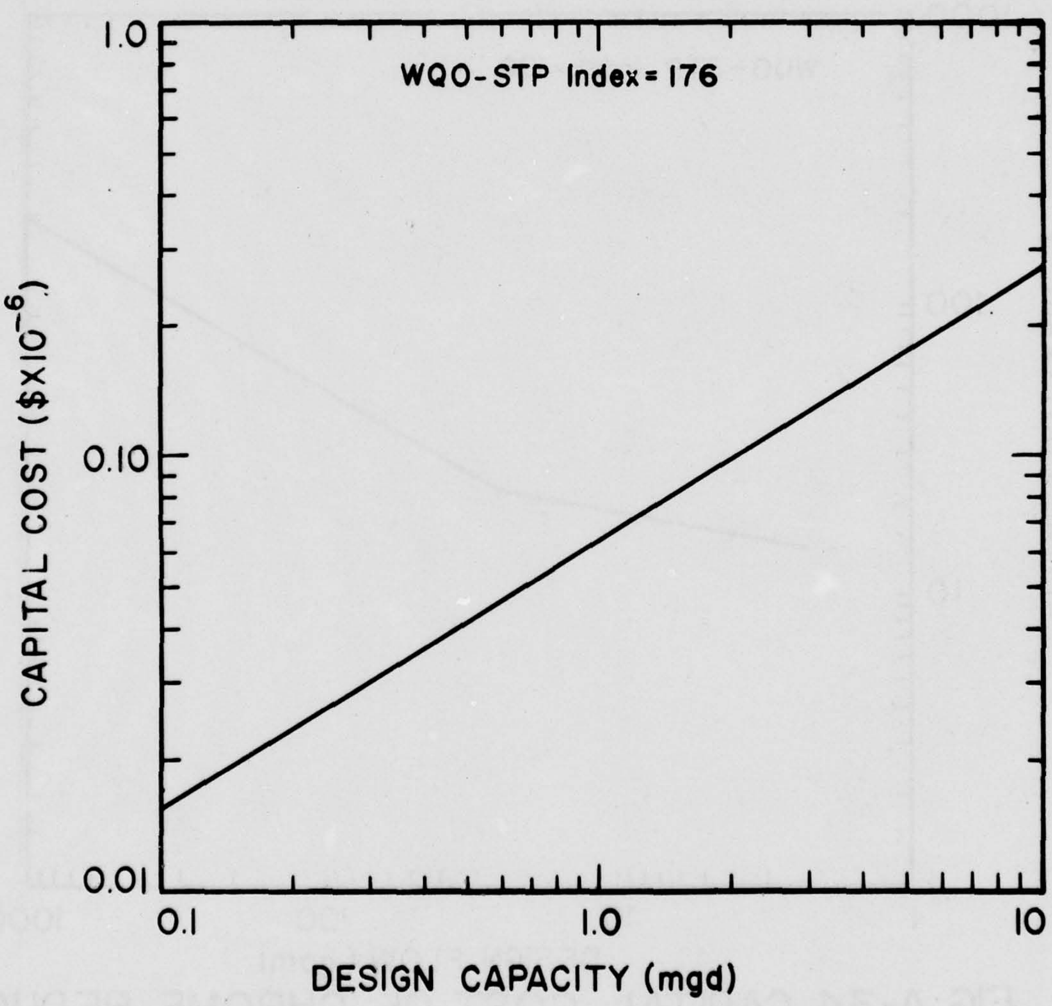

FIG. A-35. CAPITAL COST OF COOLING TOWER

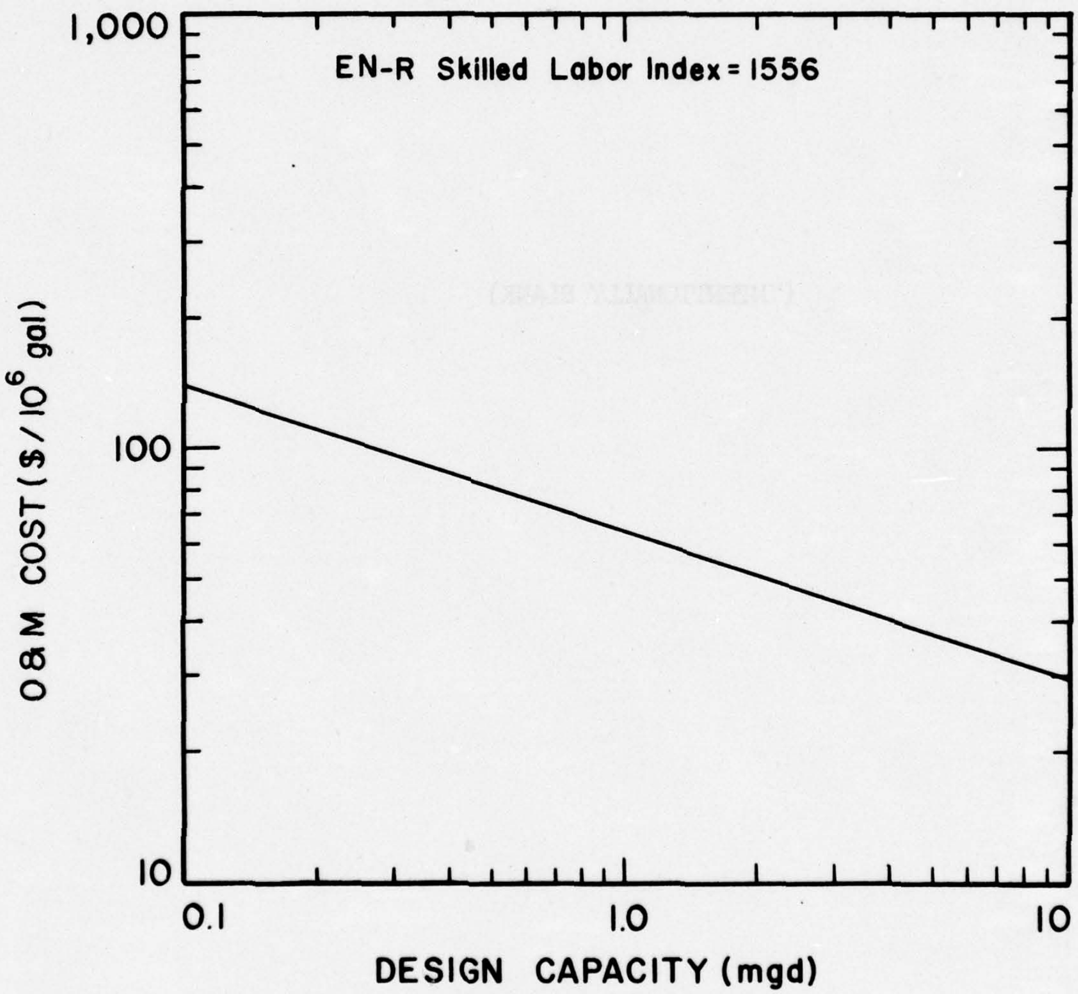

FIG. A-36. OPERATION AND MAINTENANCE COSTS FOR COOLING TOWERS

ATTACHMENT B

INDUSTRIAL TREATMENT

COST ESTIMATES

This section contains cost estimates for the treatment designs discussed in the chapter entitled "Design and Cost Analysis for Individual Treatment Facilities." Capital costs and annual operation and maintenance costs are presented in addition to the present worth of each design. Only the 7 percent present worth value is given in this attachment although 5 3/8 and 10 percent values were computed for determining total costs for the Study Area.

TABLE B-I

TREATMENT COST FOR INORGANIC CHEMICAL INDUSTRY WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Equalization	100,000	50	-	-	-	-	-
	Neutralization	320,000	25	320,000	58,944	71,200	-	-
	Filtration	160,000	40	160,000	10,688	37,500	-	-
	Control House	22,000	50	-	-	-	-	-
	Contingency & misc.	272,000	-	-	-	-	-	-
	Total	874,000			69,632	108,700	1,500,060	2,143,692
2,3,4	Equalization	100,000	50	-	-	-	-	-
	Neutralization	320,000	25	320,000	58,944	71,200	-	-
	Filtration	160,000	40	160,000	10,688	37,500	-	-
	Demineralization	1,200,000	20	1,200,000	390,240	257,300	-	-
	Control House	22,000	50	-	-	-	-	-
	Contingency & misc.	814,500	-	-	-	-	-	-
	Total	2,616,500			459,872	366,000	5,050,800	8,127,172

[a] Costs based on 1.5 mgd flow; see treatment sequence in Figures 1 and 2.

[b] Present worth calculated for 7 percent interest.

TABLE B-I (Cont.)

COST SUMMARY FOR TREATMENT OF INORGANIC CHEMICALS WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
5	Equalization	100,000	50	-	-	-	-	-
	Neutralization	75,000	25	75,000	-	72,000	-	-
	Contingency & Misc.	79,000	-	-	-	-	-	-
		254,000			13,800		993,600	1,261,400

[a]Costs based on 1.5 mgd flow.

[b]Present worth calculated for 7 percent interest.

TABLE B-II

TREATMENT COST FOR LATEX INDUSTRY WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Air Flotation	30,000	30	30,000	3,942	13,400	-	-
	Precoat Filtration	130,000	25	130,000	23,946	15,400	-	-
	Filtration	24,000	40	24,000	1,603	6,300	-	-
	Demineralization	105,000	20	105,000	34,146	15,500	-	-
	Control Structure	3,000	50	-	-	-	-	-
	Contingency & Misc.	132,000	-	-	-	-	-	-
	Total	424,000			63,637	50,600	698,280	1,185,917
2,3,4	Air Flotation	30,000	30	30,000	3,942	13,400	-	-
	Precoat Filtration	130,000	25	130,000	23,946	15,400	-	-
	Filtration	24,000	40	24,000	1,603	6,300	-	-
	Demineralization	230,000	20	230,000	74,796	22,800	-	-
	Control Structure	4,000	50	-	-	-	-	-
	Contingency & Misc.	189,000						
	Total	607,000			104,287	57,900	799,020	1,510,307

[a] Costs based on 0.104 mgd flow; see treatment sequence in Figures 3 and 4.

[b] Present worth calculated for 7 percent interest.

TABLE B-II (Cont.)

COST SUMMARY FOR TREATMENT OF LATEX WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
5	Air Flotation	30,000	30	30,000	3,900	13,400	-	-
	Precoat Filtration	130,000	25	130,000	23,900	15,400	-	-
	Contingency & Misc.	72,000	-	-	-	-	-	-
		232,000			27,800	28,800	398,000	657,800

[a]Costs based on 0.104 mgd flow.

[b]Present worth calculated for 7 percent interest.

TABLE B-III

TREATMENT COST FOR RUBBER INDUSTRY WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Equalization	150,000	50	-	-	-	-	-
	Air Flotation	105,000	30	105,000	13,797	46,500	-	-
	Precoat Filtration	260,000	25	260,000	47,892	93,000	-	-
	Filtration	100,000	40	100,000	6,680	20,000	-	-
	Demineralization	700,000	20	700,000	227,640	181,000	-	-
	Control Structure	25,000	50	-	-	-	-	-
	Contingency & misc.	592,000		-	-	-	-	-
	Total	1,946,000			296,000	340,500	4,699,000	7,766,000
2,3,4	Equalization	85,000	50	-	-	-	-	-
	Air Flotation	70,000	30	70,000	9,198	27,700	-	-
	Precoat Filtration	260,000	25	260,000	47,892	93,000	-	-
	Filtration	76,000	40		5,077	18,850	-	-
	Equalization	85,000	50	-	-	-	-	-
	Air Flotation	70,000	30	70,000	9,198	27,700	-	-
	Demineralization	900,000	20	900,000	292,680	192,700	-	-
	Filtration	125,000	40	125,000	8,350	30,000	-	-
	Control Structure	25,000	-	-	-	-	-	-
	Contingency & misc.	766,600	-	-	-	-	-	-
	Total	2,462,600			372,395	389,950	5,381,310	8,216,305

[a] Costs based on 1.8 mgd flow for Alternative 1, 2.2 mgd flor for Alternatives 2,3,4; see treatment sequence in Figures 5 and 6.

[b] Present worth calculated for 7 percent interest.

TABLE B-IV

TREATMENT COST FOR COKE PLANT WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Quench Sedimentation	55,000	30	55,100	7,340	9,500	-	-
	Activated Sludge	390,000	50	-	-	13,000	-	-
	Secondary Clarification	97,000	30	97,000	11,432	25,000	-	-
	Filtration	120,000	40	120,000	8,016	31,000	-	-
	Demineralization	520,000	20	520,000	169,104	101,000	-	-
	Vacuum Filtration	80,000	25	80,000	14,736	48,300	-	-
	Ozonation	20,000	20	20,000	6,500	5,000	-	-
	Cooling Tower	40,000	20	40,000	13,800	2,000	-	-
	Control House	35,000	50	-	24,715	14,600	-	-
	Contingency & misc.	610,000	-	-	-	-	-	-
	Total	1,973,100			254,843	246,400	3,387,000	5,615,000
2,3,4,5	Quench Sedimentation	55,100	30	55,100	7,340	9,500	-	-
	Activated Sludge	300,000	50	-	-	16,000	-	-
	Secondary Clarification	97,000	30	97,000	11,432	25,000	-	-
	Filtration	120,000	40	120,000	8,016	31,000	-	-

TABLE B-IV (cont.)

TREATMENT COST FOR COKE PLANT WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
2,3,4,5 (Cont'd)	Demineralization	850,000	20	850,000	276,420	211,000	-	-
	Vacuum Filtration	80,000	25	80,000	14,736	48,300	-	-
	Ozonation	20,000	20	20,000	6,500	5,000	-	-
	Cooling Tower	80,000	20	80,000	26,000	3,000	-	-
	Control House	35,000	50	129,000	41,951	23,400	-	-
	Contingency & misc.	775,000	-	-	-	-	-	-
	Total	2,412,000			392,295	372,200	5,137,000	7,941,000

[a]Costs based on 1 mgd flow; see treatment sequence in Figures 7 and 8.

[b]Present worth calculated for 7 percent interest.

TABLE B-V

COST SUMMARY FOR TREATMENT OF BLAST FURNACE PLANT WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Chem. Pptn. Unit	390,000	30	390,000	51,246	57,800	-	-
	Vacuum Filtration	75,000	25	75,000	13,815	48,300	-	-
	Holding Basin	170,000	50	-	-	-	-	-
	Cooling Tower	541,000	20	541,000	175,933	69,000	-	-
	Contingency & misc.	539,000	-	-	-	-	-	-
	Total	1,731,000			240,994	175,100	2,416,380	4,388,374
2,3,4,5	Precipitation Unit	90,000	30	90,000	51,246	30,000	-	-
	Filter	80,000	40	80,000	5,344	21,100	-	-
	Holding Basin	170,000	50	-	-	-	-	-
	Cooling Tower	568,000	20	568,000	184,714	75,900	-	-
	Vacuum Filtration	30,000	25	30,000	5,526	15,300	-	-
	Demineralization	520,000	20	520,000	169,104	115,600	-	-
	Control House	35,000	50	-	-	-	-	-
	Contingency & misc.	675,000	-	-	-	-	-	-
	Total	2,168,000			415,934	257,900	3,559,020	6,142,954

[a]Costs based on 11.5 mgd flow; see treatment sequence in Figures 9 and 10.

[b]Present worth calculated for 7 percent interest.

TABLE B-V (Cont.)

TREATMENT COST FOR BLAST FURNACE WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
2,3,4,5	Precipitation Unit	390,000	30	390,000	51,200	57,800	-	-
	Filtration	170,000	40	170,000	11,400	66,500	-	-
	Holding Basin	170,000	50	-	-	-	-	-
	Cooling Tower	541,000	20	541,000	176,000	69,000		
	Vacuum Filtration	75,000	25	75,000	13,800	48,300	-	-
	Demineralization	1,300,000	20	1,300,000	423,000	292,000	-	-
	Control House	50,000	50	-	-	-	-	-
	Contingency & Misc.	1,219,000	-	-	-	-	-	-
		3,915,000			675,400	533,600	7,364,000	11,954,000

[a]Costs based on11.5 mgd flow; see treatment sequence in Figure 10.
[b]Present worth calculated for 7 percent interest.

TABLE B-VI

TREATMENT COST FOR STEEL FURNACE WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Thickening	130,500	30	130,500	17,148	46,000	-	-
	Vacuum Filtration	44,000	25	44,000	8,105	23,600	-	-
	Filtration	160,000	40	160,000	10,688	42,200	-	-
	Cooling Tower	100,000	20	100,000	32,520	19,100	-	-
	Control House	22,500	50	-	-	-	-	-
	Contingency & misc.	206,000	-	-	-	-	-	-
	Total	663,000			68,461	130,900	1,806,420	2,138,000
2	Thickening	130,500	30	130,500	17,148	46,000	-	-
	Vacuum Filtration	44,000	25	44,000	8,105	23,600	-	-
	Filtration	70,000	40	70,000	4,676	29,200	-	-
	Holding Basin	42,000	50	-	-	-	-	-
	Cooling Tower	135,400	20	135,400	44,032	28,000	-	-
	Control House	10,000	50	-	-	-	-	-
	Contigency & misc.	195,200	-	-	-	-	-	-
	Total	627,100			73,961	126,800	1,749,840	2,450,900

[a]Costs based on 1.5 mgd flow for Goal I; 0.5 for Goal II; see treatment sequence in Figures 11 and 12.

[b]Present worth calculated for 7 percent interest.

TABLE B-VI (Cont.)

TREATMENT COST FOR STEEL FURNACE WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
3,4,5	Thickener	130,500	30	130,500	17,100	46,000	-	-
	Vacuum Filtration	44,000	25	44,000	8,100	23,600	-	-
	Filtration	160,000	40	160,000	10,700	42,200	-	-
	Holding Basin	42,000	50	-	-	-	-	-
	Cooling Tower	134,000	20	134,000	44,600	30,700	-	-
	Control House	22,500	50	-	-	-	-	-
	Contingency & Misc.	263,500	-	-	-	-	-	-
		846,500			80,500	142,500	1,966,500	2,909,000

[a]Costs based on 1.5 mgd flow; see treatment sequence in Figure 12.
[b]Present worth calculated for 7 percent interest.

TABLE B-VII

TREATMENT COST FOR HOT ROLLING MILL WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Chem. Ppnt. Unit	6,800,000	30	6,800,000	893,520	985,000	-	-
	Vacuum Filtration	2,730,000	25	2,730,000	502,466	583,000	-	-
	Holding Basin	600,000	50	-	-	-	-	-
	Cooling Tower	1,225,000	20	1,225,000	398,000	235,400	-	-
	Control House	325,000	-	-	-	-	-	-
	Contingency & misc.	5,279,000	-	-	-	-	-	-
	Total	16,959,000			1,793,986	1,803,400	24,887,000	43,646,676
2,3,4,5	Chem. Pptn. Unit	6,800,000	30	6,800,000	893,520	985,000	-	-
	Vacuum Filtration	2,730,000	25	2,730,000	502,466	583,000	-	-
	Holding Basin	600,000	50	-	-	-	-	-
	Cooling Tower	1,225,000	20	1,225,000	398,000	235,400	-	-
	Filtration	1,020,000	40	1,020,000	68,136	379,400	-	-
	Cooling Tower	1,218,000	20	1,218,000	396,094	125,000	-	-
	Control House	325,000	-	-	-	-	-	-
	Contingency & misc.	6,290,000	-	-	-	-	-	-
	Total	20,208,000			2,258,216	2,307,800	31,848,640	54,320,626

[a]Costs based on 61.5 mgd flow; see treatment sequence in Figures 13 and 14.

[b]Present worth calculated for 7 percent interest.

TABLE B-VIII

TREATMENT COST FOR COLD ROLLING MILL WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1,2,3,4,5	Holding Tank Froth Flotation Filtration Holding Tank	1,214,000	30	1,214,000	159,520	17,000	-	-
	Holding Tank	42,000	50	-	-	-	-	-
	Precoat Filtration	250,000	25	250,000	46,050	94,900	-	-
	Equalization Emulsion Breaking Air Flotation	1,257,000	30	1,257,000	1,651,698	30,600	-	-
	D.E. Filtration	920,000	20	920,000	299,184	43,700	-	-
	Control House	25,000	-	-	-	-	-	-
	Contingency & misc.	1,676,000	-	-	-	-	-	-
	Total	5,384,000			2,156,452	188,200	2,597,160	10,137,612

[a] Costs based on 2 mgd flow; see treatment sequence in Figure 15 .

[b] Present worth calculated for 7 percent interest.

TABLE B-IX

TREATMENT COST FOR PICKLE RINSE WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Neutralization	400,000	25	400,000	73,680	132,900	-	-
	Contingency & misc.	181,000	-	-	-	-	-	-
	Total	581,000				132,900	1,834,020	2,488,700
2	Neutralization	250,000	25	250,000	46,050	71,540	-	-
	Demineralization	550,000	20	550,000	178,860	128,000	-	-
	Control House	10,000	-	-	-	-	-	-
	Contingency & misc.	336,000	-	-	-	-	-	-
	Total	1,146,000			224,910	199,540	2,753,652	4,124,562

[a]Costs based on 0.7 mgd flow for Goal II; 1.4 for Goal I: see treatment sequence in Figures 16 and 17.

[b]Present worth calculated for 7 percent interest.

TABLE B-IX (Cont.)

TREATMENT COST FOR PICKLE RINSE WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
3,4,5	Neutralization	400,000	25	400,000	73,680	132,900	-	-
	Demineralization	1,150,000	20	1,150,000	373,980	240,200	-	-
	Control House	10,000	50	-	-	-	-	-
	Contingency & Misc.	705,000	-	-	-	-	-	-
		2,265,000			447,700	373,100	5,148,800	7,862,000

[a]Costs based on 1.4 mgd flow; see treatment sequence in Figure 17.
[b]Present worth calculated for 7 percent interest.

TABLE B-X

TREATMENT COST FOR OIL REMOVAL WITH MODERATE TDS CONCENTRATIONS[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1, 5	Oil Separation	3,300	25	3,300	608	2,000	-	-
	Contingency & misc.	1,500	-	-	-	-	-	-
	Total	4,800				2,000	27,600	33,008
2, 3, 4	Air Flotation	18,500	30	18,500	2,431	4,150	-	-
	Filtration	8,200	40	8,200	548	2,400	-	-
	Precoat Filtration	85,000	25	85,000	1,566	6,600	-	-
	Demineralization	80,000	20	80,000	26,016	14,600	-	-
	Contingency & misc.	86,600	-	-	-	-	-	-
	Total	278,300			30,561	27,750	382,950	691,811

[a] Costs based on 0.024 mgd flow; see treatment sequence in Figure 18.

[b] Present worth calculated for 7 percent interest.

TABLE B-XI

TREATMENT COST FOR OIL REMOVAL WITH HIGH TDS CONCENTRATION[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Air Flotation	24,500	30	24,500	3,219	5,800	-	-
	Filtration	12,500	40	12,500	835	3,500	-	-
	Precoat Filtration	100,000	25	100,000	18,420	9,400	-	-
	Demineralization	75,000	20	75,000	24,390	10,500	-	-
	Contingency & Misc	95,800	-	-	-	-	-	-
	Total	307,800			46,864	29,200	407,100	761,764
2, 3, 4	Air Flotation	24,500	30	24,500	3,219	5,800	-	-
	Filtration	12,500	40	12,500	835	3,500	-	-
	Precoat Filtration	100,000	25	100,000	18,420	9,400	-	-
	Demineralization	105,000	20	105,000	34,146	14,900	-	-
	Contingency & Misc	109,400	-	-	-	-	-	-
	Total	351,400			56,620	33,600	46380	817,700

[a] Costs based on 0.043 mgd flow; see treatment sequence in Figures 19 and 20.

[b] Present worth calculated for 7 percent interest.

TABLE B-XI (Cont.)

TREATMENT COST FOR OIL REMOVAL WITH HIGH TDS CONCENTRATION[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
5	Oil Separation	11,000	25	11,000	-	4,000	-	-
	Contingency & Misc.	5,000	-	-	-	-	-	-
		16,000			2,000	4,000	55,200	18,000

[a]Costs based on 0.043 mgd flow.

[b]Present worth calculated for 7 percent interest.

TABLE B-XII

TREATMENT COST FOR PLATING INDUSTRY WASTEWATER[a]

Treatment Alternative	Unit Process	Original Capital Cost ($)	Life (yr)	Replacement Cost ($)	P.W.[b] of Replacement Cost ($)	Annual O & M Cost ($/yr)	P.W.[b] of O & M Cost ($)	P.W.[b] of System ($)
1	Cyanide Destruction	19,000	30	19,000	2,497	7,600	-	-
	Chrome Reduction	17,000	30	17,000	2,234	4,000	-	-
	Neutralization	66,000	25	66,000	12,157	3,200	-	-
	Filtration	10,000	40	10,000	668	2,200	-	-
	Contingency & misc.	60,200	-	-	-	-	-	-
	Total	172,200			17,556	17,000	234,600	424,356
2	Cyanide Destruction	16,000	30	16,000	2,102	7,100	-	-
	Chrome Reduction	15,000	30	15,000	1,971	3,500	-	-
	Neutralization	62,000	25	62,000	11,420	1,800	-	-
	Filtration	6,200	40	6,200	414	1,800	-	-
	Demineralization	28,000	20	28,000	9,106	3,800	-	-
	Contingency & misc.	57,500	-	-	-	-	-	-
	Total	184,700			25,013	18,000	248,400	458,113

[a]Costs based on total waste flow of 31,300 gpd for Goal I and 15,650 gpd for Goal II; see treatment sequence diagram in Figures 21 and 22 for unit process flows.

[b]Present worth calculated for 7 percent interest.